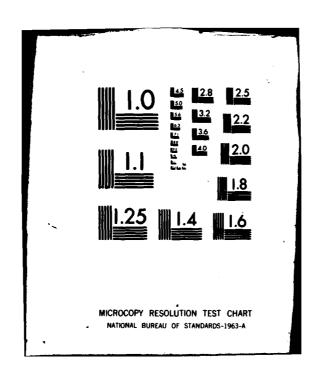
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A HEURISTIC ROUTE SELECTION MODEL FOR LOW LEVEL AIRCRAFT FLIGHT THROUGH DEFENDED TERRAIN

Michael James Dorsett Plans, Analysis, and Evaluation Directorate US Army Missile Command

MAY 1980

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U.S.ARMY MISSILE COMMAND

Redstone Arsenal, Alabama

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has forced aircraft to utilize low level flight to	avoid detection, thereby
increasing survivability. By identifying the high	and low points within an
area, the model determines their exposure values, w	hich are utilized with their
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## CHAPTER I

#### INTRODUCTION

## 1.1 Background

Throughout history man has engaged in battle with his fellow man. A review of history is a review of warfare. Man seems to have a general propensity to consider warfare a major objective in his life. The early settlers of this country encountered a formidable foe in the native Americans. The covered wagon caravans were the early settlers' attempts to minimize the Indian threat when traveling West. Further, the scouts would seek high vantage points in the terrain where they could observe and provide early warning of enemy forces and their movement.

Scientific and technological developments have provided present day man with complex equipment and devices with which to do battle with his enemies. Commonplace among this arsenal are missiles, high performance aircraft, helicopters, air defense systems, tanks, radars, submarines, and a host of sophisticated hand-held weapons including lasers. It should be noted that the radar replaces the observer on the lonely hill top, while tanks and armoured vehicles replace the covered wagons. The major difference in the two scenarios is the equipment of which aircraft, missiles and air defense systems are of concern in this research effort. It is with the concept of air defense that modeling becomes paramount, since models permit reality to be depicted for a very modest investment of time and money.

## 1.2 Air Defense Modeling

The effectiveness of medium and high air defense systems impose a high degree of risk to aircraft survivability when an aircraft is operating in the air space protected by these systems. This situation leaves low level flight as the only option oper to the aircraft to avoid these air defenses. Aircraft are a high value resource which must be utilized wisely. Regardless of the results of the analysis, the mission has to be undertaken. The battle, and in turn the war, can only be won if one attacks. Thus, one must enhance the aircraft's probability of survival.

One means to increase the aircraft's chances of survival is to plan a route which minimizes its exposure to enemy air defenses. A terrain following route can be optimized in the vertical plane, but the initial question is where to position the ground track in the horizontal plane that the aircraft will follow. If one knew the route which minimized the exposure, then there would be an easing of the vertical constraint imposed by the air defenses [1].

The objective of this research is to develop a heuristic method for selecting a minimum-exposure, minimum-elevation route for terrain following flight through defended terrain. Considering the expensive aircraft in use today, the computer modeling of air operations on the tactical battlefield is a useful tool for assessing tactics, performance, and results.

## 1.3 Research Topic

If one knew the location of low exposure routes, then an assessment could be made on the expected outcome of employing these routes. The high exposure route is merely to allow the aircraft to fly within the

radar coverage. This research was undertaken to find a method which allows one to find the low exposure route from some initial point to a destination point.

A minimum exposure route will logically use terrain features to hide the aircraft from the air defense sensors. This assumption implies that low elevation areas should have a lower exposure profile than high elevation areas. It is intended to use the low elevation areas as the basic units from which a minimum exposure route can be built. Thus, a heuristic route selection model will be developed in this dissertation that achieves a minimum-exposure, minimum-elevation route for low level flight.

## 1.4 Outline of Succeeding Chapters

Chapter II is a review of the literature pertaining to routing, aircraft and air defense. Three documents of particular interest to this research are discussed first. The remainder of the chapter pertains to the literature in general. The tactical situation from which this research derives is given in Chapter III. The scenario is typical of a medium intensity battle. The development of the model is presented in Chapter IV. The discussion follows the solution sequence of the model.

Chapter V is an example of the model selecting an appropriate route for the prescribed conditions. The calculations are based on the material of Chapter IV. The model results are contained in Chapter VI. The results for two small terrain areas are presented first, followed by the results for a much larger terrain area.

Chapter VII is the validation of the developed model. Some of the model results are compared to manually developed, preferred routes. Finally, Chapter VIII presents the conclusions of this research and recommendations for further research.

#### CHAPTER II

#### LITERATURE REVIEW

#### 2.1 Introduction

An intensive review of the literature identifies three research results which are pertinent to this effort. A recent dissertation by James E. Funk [2] provides a method for determining the optimal vertical flight path for a given route. The second effort was reported in The University of Alabama in Huntsville Research Institute (UARI) Report, Optimal Attack Route Selection Method [3]. The third research of interest is a Helicopter Route Selection Model developed by Ohio State University for the large land combat model DYNTACS [4]. In addition, the literature pertaining to network modeling, computer software algorithms, geology and geography, highway routing, and electronic circuit routing were investigated to determine their applicability in aircraft routing.

Modern air defense systems have the capability to deny medium or high altitude aircraft attack routes to a target. To overcome this restriction, low level flight has now become a preferred method for penetrating air defenses. Low level or terrain following flight paths, however, presents the problem of impact with the terrain. In the literature this problem is also referred to as clobber.

The ideal flight path for terrain following would be a flight curve that matches the terrain curvature by some clearance height above the local terrain. The aircraft control system limits the vehicle to flying a smooth flight path which approximates this clearance curve. Figure 2.1

is an illustration of a typical terrain profile with the clearance curve and flight path for low level flight. The slower the aircraft flies the closer the flight path can approximate the clearance curve.

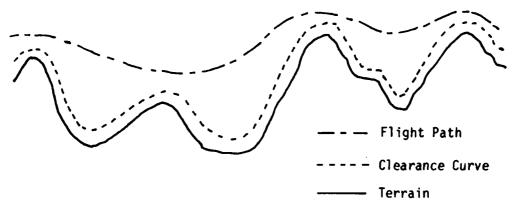


Figure 2.1. Low Level Flight Profile.

The review of unclassified documents concerning low level flight has centered on the problem of optimal aircraft control systems. Advances in microprocessors and digital electronics seem to be the controlling factor in increasing the capability of on-board flight computers and navigation systems [2, 5, 6]. With increased on-board computer capacity, real time optimization of flight profiles become possible, thereby achieving an optimal low level flight path along the selected route.

In the literature that was reviewed, a major consideration in any air defense study is terrain modeling. Terrain modeling is also utilized in such studies as highway routing and construction, pipeline routing, and land use. Most recent research in this area is directed at using computer graphics to depict the terrain in contour map form and in picture form. Existing terrain models are presently adequate for air defense modeling [7, 8, 9, 10, 11]. The terrain models, however, do not provide for aircraft route selection analysis.

## 2.2 Reported Research

The dissertation by J. E. Funk presents a mathematical programming method for solving the aircraft control problem in terrain following flight [2]. The first step in his approach was to construct a trajectory model which is incorporated into the objective function or, as he has defined it, the performance function. The performance function is defined in terms of an excess clearance variable. The function is optimized subject to differential constraints of height, slope and curvature of the flight path.

To provide computational ease the problem is discretized. The performance function and constraints are transformed to a matrix form which can now be considered as a quadratic or linear programming (LP) problem. This quadratic or LP problem is solved using existing algorithms. To develop a complete flight path this procedure considers overlapping segments. Segment i of the flight path is optimized and then the next overlapping segment, i+1, is optimized with the initial portion of segment i+1 defined by segment i. Since the discrete segments overlap, the resulting flight path is continuous and there are no discontinuities at the boundaries.

In Funk's research, only the vertical terrain avoidance is examined, and not the lateral terrain avoidance. His results give a solution to the aircraft control system to yield the optimal flight path over a given terrain route.

In the UARI report, a dynamic programming approach for determining optimal attack routes is presented [3]. Although this work was performed several years ago, it is still current with techniques recently reported. The backwards solution method was employed to evaluate the recursive function.

The route selection process that was developed is a direct application of dynamic programming. To represent the multi-stage decision process, a grid network was used where each grid point is equivalent to a stage in the decision process. Thus, the optimal decision path is the optimal attack route.

The probability of survival,  $(P_s)$ , is the return at each stage. The optimal path has the highest probability of survival or is the 'least risk route. The probability of survival at a grid point is given by:

 $P_{s} = (1 - P_{k}).$ 

The probability of kill  $(P_k)$  for an air defense site is the resultant of the probabilities of acquisition, tracking, missile launch, missile flight, and warhead lethality.

Two recommendations for further research in this report were of interest. This technique had only been applied to small scale problems, and further research on large scale problems with multi-attackers and multi-radar sensors were suggestions for consideration. Also, it was recommended that network techniques such as shortest path or least cost path be considered.

The Helicopter Route Selection Model that has been developed is another method using dynamic programming [4]. This model is an adaptation of the ground unit route selection model that is a subroutine of DYNTACS X. The first step is to determine the intervisibility areas for each weapon. These areas define the masked and unmasked portions of the battlefield. From the set of masked areas a series of concealed areas in close proximity to one another can be connected to form an avenue of approach. Having identified this avenue the route can be selected that follows the general shape of the approach corridor.

Up to this point all analyses of intervisibility and terrain have been performed outside of the actual model. With the process completed the route corridor is defined in the model. The intervisibility areas are defined by a set of irregular convex shapes having straight line boundaries between each vertex. Along each boundary one or more points define the possible beginning (or end) of a route segment across the convex shapes (Figure 2.2). These points are shown as circles on Figure 2.2 and are also entered into the model as data.

With the terrain area thus described for the model, the route selection routine can be utilized. A series of nine points that are in the direction of attack are selected for route analysis. The selection routine evaluates these boundary points identified by the probability of survival at each point. The point with the highest probability of survival is selected and then the next series of nine points along the route corridor are considered. This process is the forward solution method for dynamic programming problems.

## 2.3 Open Literature

One of the first areas in the open literature to be investigated was cluster analysis. An excellent presentation of cluster analysis can be found in Anderberg's text [12]. When data has no discernible pattern, cluster analysis can provide a tool to uncover the pattern. Hierarchical clustering is widely utilized to develop the linking of data as each entity is processed. In this research, the idea of nearest neighbor and centroid of a cluster that is used with non-hierarchical clustering, are utilized as a basis for processing the terrain data.

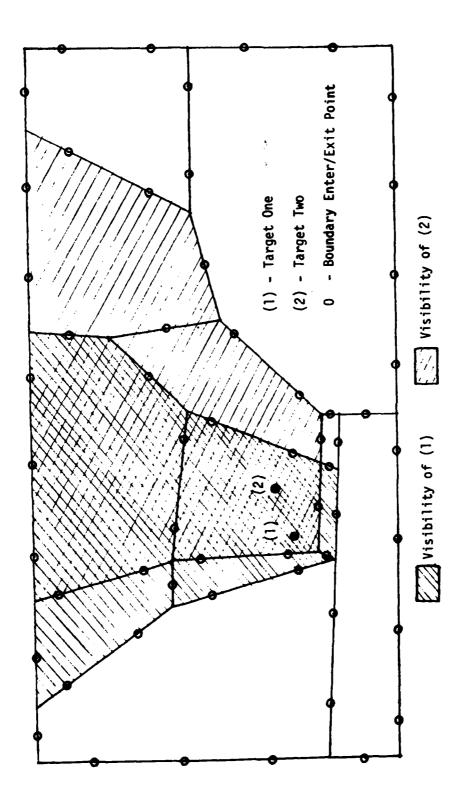


Figure 2.2. Partitioned Terrain Area.

For a data set of N observations, clustering into subsets of like values indicates an association or similarity for the cluster membership which is not shared by those outside that cluster. Typically, the members of a cluster will minimize some criterion such as minimal distance from the mean of the cluster. The mean of a cluster can be utilized as the centroid. For the total data set of k clusters, membership in cluster i can have a point to centroid distance different from cluster j, which would indicate an individual cluster density. Thus, a higher order clustering can be performed on the initial clusters because their centroids are now the data points. The centroids of the first order cluster can be weighted according to density and be the point used as the value for the higher order clustering.

Clustering methods are means by which data can be grouped, associated, or placed in some classification scheme for analysis. There is no one preferred method to be used, as several methods normally need to be used to determine if there is any pattern or intelligence to be derived from the data.

The aircraft routing problem can be formulated as a network or a graph problem. In the literature, the theoretical aspects of a network are referred to as graph theory, whereas the practical aspects are known as network analysis. A highway network connecting cities would be vertices for the cities and edges for the highways when related to graph theory. Networking would refer to the cities as nodes and the highways as arcs. Depending on the reference, the terminology for the cities could also be called junction points, intersection points, or simply points; and likewise, an arc could also be a branch, link, path or line.

For a network or graph G there is a collection of points  $x_1, x_2, \ldots, x_n$  (denoted by the set X), and a collection of lines  $a_1, a_2, \ldots, a_m$  (denoted by the set A) which join some or all of these points. The graph is described and denoted by the doublet G(X,A) [13]. An edge joining  $x_i$  with  $x_j$  is denoted by  $[x_i, x_j]$ .

In network analysis and cluster analysis there are three distance measures that are of interest. First, the standard Euclidean distance or metric for two points in space is given by:

$$d = \left[ (x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2 \right]^{\frac{1}{2}}.$$

Second, in many location problems, especially in urban areas, travel is along an orthogonal set of streets. Travel which is restricted to directions parallel to the coordinate axes use a rectilinear or Manhattan metric that defines distance between two points  $(x_1, y_1)$  and  $(x_2, y_2)$  by:

$$|x_1-x_2| + |y_1-y_2|$$
.

The rectilinear metric could have been used in the UARI Optimal Attack Route Method since travel was restricted to grid lines. Third, when travel is restricted to take place on a network, then the internode lengths are the distance measure [14].

The above concepts were utilized in developing the approach to the route selection process for low flying aircraft. The ideas of nearest-neighbor and cluster centroid form the bases for the terrain data reduction.

## CHAPTER III

#### PROBLEM FORMULATION

## 3.1 Tactical Scenario

This research considers an area of air defense war gaming. There are two basic situations that a tactician can analyze. In one case, the tactical situation is portrayed from the defender or air defense site aspect. For the other case, the tactical situation is presented from the attacker or pilot's viewpoint. The specific problem this research addresses is that of selecting a route which a low flying air-craft can use to penetrate the air defense coverage, while at the same time minimizing the aircraft exposure to these defenses. Low flying aircraft ordinarily fly within 200 meters of the terrain.

The defender desires to allocate his air defenses in a pattern to achieve maximum coverage. The sensors (radar, infrared, or visual) are positioned in the terrain to be defended such that visibility is maximum in the principle direction the site is responsible for protecting. In actual terrain there can be certain azimuths for which coverage is marginal or non-existent. To ensure that the total area is covered, the air defense sites are situated so that individual site visibilities overlap each other thereby providing a pattern with total coverage. Thus, any portion of the total area is being covered by one or more air defense sites. The attacker is faced with the situation of attempting to select a route which avoids these sites and maximizes his survival while reaching the target, and accomplishing the mission.

Along with terrain following, there are some other options the tactician can choose to enhance the aircraft and pilot's survivability. The attacker can use electronic countermeasures (ECM), better known as jamming. An anti-radiation missile (ARM) could be fired at each radar. Decoys or remotely piloted vehicles (RPV's) could be utilized to saturate the skies so that an aircraft can be hidden among the RPV's. To reach the primary target, a preemptive raid could be made against the air defenses. Of course, the defender is fully aware of these and other methods that can be employed to negate the air defense's ability to engage the attackers.

#### 3.2 Aircraft Route Selection

In this research, the air defense situation is a heavily defended 35 by 35 km area through which a helicopter force must penetrate. The air defense sensors are assumed to be deployed within this region such that maximum coverage exists.

Using military terminology, the line of battle between two forces is known as the forward edge of the battle area (FEBA). The helicopter force is flying a terrain following flight path from their base across FEBA to raid an enemy rear area base. The enemy air defense sensor capability is assumed to have good low altitude coverage for a 10 km radius and good long range coverage for medium and high altitude.

In performing this raid, the objective is to traverse the whole route undetected, thus preserving the element of surprise in the attack. The air defense sensors are not being attacked or jammed in this raid. In an attempt to obscure the helicopters' approach to the target, the mountains and hills would be utilized as a mask. Intuitively, the best low level aircraft route would follow the lowest terrain. To offset this

tactic, the enemy will position some air defense sites to cover low altitude corridors into his area.

The interaction of these tactics results in the helicopter route selection being that of finding the low level route which has the fewest air defense sites covering it. Thus, a route is a linkage of several low level path legs into a continuous path that will allow the aircraft to avoid detection.

## 3.3 Sensor Coverage

With low altitude targets, radar sensors have clutter problems when receiving the return signal. There can be a high level of noise because of ground objects and terrain features which tend to obscure any targets that may be nearby. Any aircraft operating in an area with opposing air defenses will attempt to fly as low as possible so as to be in the clutter of the radar return signal. However, the faster the aircraft speed the higher it must fly to be responsive to the pilot's terrain avoidance commands. Thus, the aircraft pilot has two conflicting constraints; first, the aircraft must fly no higher than X meters to avoid detection, yet, second, it must fly at least Y meters above the terrain to maintain a clearance altitude. A major problem exists for the pilot when Y is greater than X.

The degree of coverage a radar site possesses from a given location is dependent on the target altitude and the local terrain. An aircraft at 50 meters altitude is more likely to be detected than an aircraft at 20 meters altitude. To graphically illustrate sensor visibility, a series of actual coverage diagrams for three sites were made at target altitudes of 20 and 50 meters. Penetrating aircraft are assumed to be approaching the sites from the west (left edge of figures). Coverage diagrams are

generated using a computer routine that generates the visibility from a site to the target altitude for 0 to 360 degrees in azimuth.

The first site, Figure 3.1, has excellent coverage to the west at each altitude. For increasing target altitudes only a small improvement in visibility is obtained. Visibility for a 10 km radius at 20 meters target altitude is 28.02 percent of the total area. At 50 meters, visibility is 31.85 percent.

In Figures 3.2 and 3.3, the site has good coverage at each altitude. At 20 meters target altitude, visibility is 29.85 percent and improves to 43.10 percent at 50 meters. The prominent direction of coverage is west, but this site also has some coverage to the east.

Lastly, in Figure 3.4, a poor site location is shown. Visibility at this site varies from 5.31 percent at 20 meters to 8.63 percent at 50 meters. Coverage provided by this site is southerly.

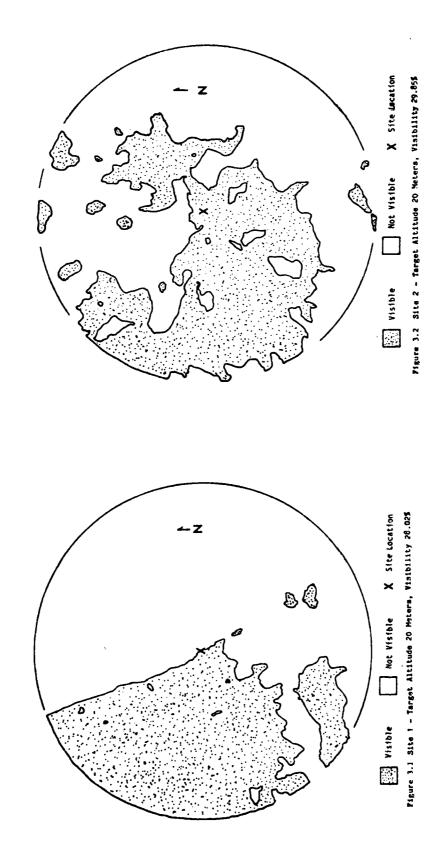
These three site locations are deployed in the same area and the composite coverage is shown in Figure 3.5. In the overall coverage, the poorly situated site provides sensor detection to the south which the other sites lack. Thus, the poor location is better than expected because it furnishes satisfactory coverage when considering the combined coverage.

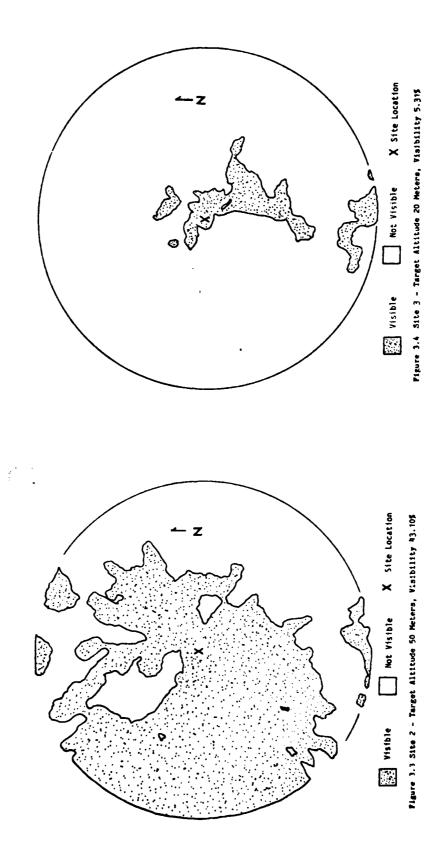
As can be seen in these series of figures, the coverage of an area by air defense sensors limits the ability of an aircraft to penetrate the area undetected. The deployment of several air defense sites imposes a visibility constraint on the selection of routes through the area. It may be impossible to find an undetectable corridor.

## 3.4 Terrain Data

The terrain data base used in this research is Defense Mapping

Agency (DMA) terrain data which provides the height above sea level for





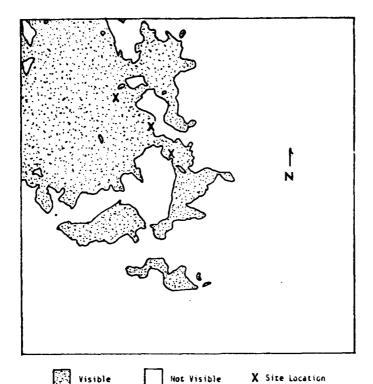


Figure 3.5 Composite of Sites 1, 2, and 3, Target Altitude 20 Heters

each terrain location. A granularity of 70.0 meters was selected in utilizing the data base. A problem with this fine a grid is the quantity of data points for even a moderate size area. For a 20 by 20 km area, this density results in 90,000 entries.

The first requirement in utilizing this data is to convert from a packed format into an array format of unpacked terrain points. The geographical area selected requires a 525 by 525 array (35 by 35 km). Since this array is too large for efficient computer processing, the area was partitioned into smaller arrays of 15 by 15. This arrangement results in a strip of 35 arrays to cover the north-south direction and 35 strips in the east-west direction (Figure 3.6). A map sheet is 15 data points from west to east, and 35 arrays of 15 data points from south to north.

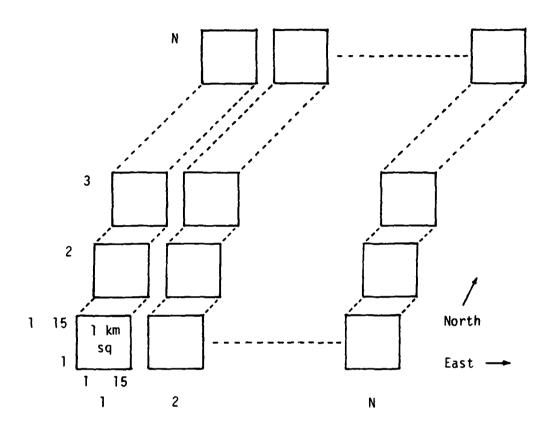


Figure 3.6. Terrain Data Arrays.

Once the terrain data is available from the conversion processing, some assumptions need to be made relating the data to the route selection problem. The premise that the aircraft route will follow the valleys and low areas requires that the low elevation terrain be identified from the terrain data. Thus, it is assumed that by a grouping or clustering process, these low elevation areas can be found. Also, the partitioning of the area allows for identification of local minimum altitudes rather than a single global value.

An example of terrain data arrays is shown in Table 3.1. As can be seen in this table, the variation in the point to point values can be stratified. Once the data is grouped into elevation intervals (or bands), the terrain relief is shown as plateaus with the lowest plateau being the lowest elevation area. The lowest stratum is a cluster of lowest terrain points from which the cluster center can then be used as a node point in the routing network.

With the terrain data analyzed and the node points established, the route can now be developed. The terrain route for the helicopter has only two known points at the onset - the initial point and the terminal point. All intermediate route points need to be selected from the nodes.

Table 3.1 Elevation Array

399	399	399	399	397	004	004	004	004	399	399	399	399	359	399	399	399	399	199	399	399	399	399	399	399	399	398	398	398	399
399	399	39B	004	004	395	394	394	397	004	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	39e	398	004	396
397	399	00+	395	391	388	3.6.7	389	391	396	004	399	399	399	399	399	399	399	399	399	399	199	399	359	399	397	398	387	380	374
384	384	393	386	383	380	379	381	385	3.89	392	398	004	004	004	399	399	399	399	399	399	399	399	399	397	390	388	377	368	36.1
376	376	373	369	36.5	371	172	374	377	381	4	387	390	392	395	004	199	395	399	399	399	399	399	399	399	388	378	367	357	35.0
368	367	364	360	600	351	40°	. ec	361	372	375	378	380	383	386	40.00	004	399	399	399	399	399	399	397	39.6	382	369	357	345	347
359	359	100 E	1 M	200	9 6	, <u>c</u>	200	1 E	) (C)	- ec	359	370	373	379	7. B.7		00.4	9 6 5	665	399	399	399	004	387	371	359	349	347	345
349	34.9		· 6	) d	. 4	` •		180			e C	000		358	111	702	9 6	3 5	0	399	399	199	359	377	362	34.9	347	34.5	34.5
349	647	35.0		\ d		. 0		4 4 4	4 4 4	4		4	4	350	141	3 7 7	177	. 6	0.00	. E	399	399	198	373	6 4 1	347	14 10	100	342
349	0 1	· ·	) d	` d	7 7	7 7 7	147	747		7 4	9 4			349	d 4		) F	) d	1 G	0 0	665	65		369	9	. 4	5		341
340		P 0 4	\	) ( F	7 4 4 6 4 4	N 0 4 P	F 6	7 4 4		7 4	7 7		. 4	349	9	۲ <b>د</b>	. d . d	0 P	100	0 0		000	396	0 00 1 00 1 00 1 00	9 4	, 4	9	3.40	339
0 7		)	7 6	) C C F	F 4 7	r (	7 6	7 6	)	r 0	r 0		\ \ \ \ \ \	1 <b>6 1</b>	5		r 4		C • E	000	7 0	707		36.0	9 4	, y &		7	7 EC
9		P 6	P 4	F 1	000	F 1	6 6	6	P 6	r (	r 6	247	P 4	0 4 N		, e	200	, t	0 .	7 0 0	100	C 0		0 4 4 F	9 4	144	0 4 7 4 7 F	1 4	
240	, ,	ን d e o	r (	r + 0	550	P (	(A) (	o (	F (1)	F 6	F 4	) i	P 4	3.49	;	F 10	250	100	790	000	F 6	) C	2 4 5	2 4 5	7 2	n q n ≠	0 e	0 4	3.46
0 4 2	P 4	F (	F + 0	60	640	646	6	\$ 0 C	6	<b>*</b> •	7 ( F (	F 6	P 4	6 4 6	•	•	00	926	9 1	0:	200	D G	) ( ) (	77	7 4	p 4	U W	n 6	7 7 7

#### CHAPTER IV

## MODEL DEVELOPMENT

## 4.1 Introduction

The route selection development begins with the basic terrain elevation data and ends with the minimum-exposure, and minimum elevation route. The model consists of several logical divisions that progressively solves this problem.

Initially, the model groups the terrain data into elevation bands from which cluster centroids (or centers) are developed. These centers become the node points for a routing network. Around a route node a neighborhood of node points is selected as possible links to this node. In this neighborhood each point has an exposure value which is a function of its visibility to enemy sensors, its altitude, and its distance from the node point. The exposure value is a penalty for the use of this point. Each linkage is a path or leg of the route, and all the linked nodes form a route connecting the minimum-exposure, and minimum-elevation points. The resulting path between the initial and final nodes provides a route for a penetrating low flying aircraft.

## 4.2 Clustering of Terrain Data

To group the terrain data into elevation bands the integer arithmetic feature of Fortran software is exploited. When arithmetic operations are performed on integer numbers, only the integer portion is

retained and the decimal portion is discarded. The following relation is utilized:

This calculation results in all elevation values within an INT interval of each other being assigned the maximum value of that interval. The process is identical to class intervals utilized in constructing a frequency table in statistical analysis. Instead of using the midpoint of the interval, the maximum in the class interval is used.

Once all the terrain data is stratified, then clusters of both high and low elevation points can be found. Each array of 15 by 15 covers an area of 1050 by 1050 meters. Within this area at least one low elevation cluster is identified along with a high elevation cluster. There are some cases where the whole array represents level terrain and the array consists of the same elevation values. When this situation occurs, it is necessary to check adjacent arrays to determine if this terrain is a low elevation cluster.

Since more than one low elevation cluster can occur in an array a method was developed to determine if two points were adjacent to each other. For a square grid a single point I has eight points around it as shown in Figure 4.1. The points labeled A through Q (less I) form a ring around the numbered points and cannot be adjacent to the point I.

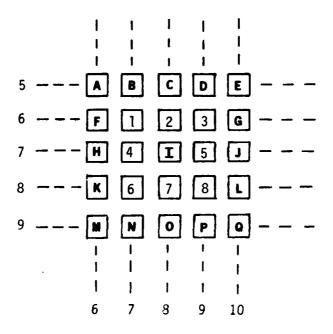


Figure 4.1 Points Adjacent to I

The array is processed sequentially by searching across each row; therefore, cluster membership is identified in order of occurrence from the beginning of the array. For example, assume that a cluster consists of the following points - I, 5, J, 7, 8 and P. These six points are a cluster located in the 15 by 15 array. The clustering procedure identifies all points of the same elevation by entering their position into a list. The indexes of a point are combined by letting INDEX = 100 (IROW) + JCOL, where IROW is the row index and JCOL is the column index. This coded number is the location of the point within the array.

In this example, let the point I be in row 7, column 8. The stored INDEX value for I is 708. The other cluster membership values are given in Table 4.1.

Table 4.1 Cluster Membership

Member	INDEX Value	I-Difference
I	708	0
5	709	1
J	710	2
7	808	100
8	809	101
Р	909	201

When searching this list for cluster membership the value of INDEX provides a means to separate clusters. Since the membership is sequential, only those points occurring after I need to be examined (points 5, 6, 7 and 8). By subtracting INDEX values the difference indicates adjacency.

For a point to be adjacent to I the difference must be either 1, 99, 100 or 101; any other value indicates that the point is separated by one or more rows (or columns). Points 5, 7, and 8 are identified as belonging to the same cluster as point I before considering the next point in the list. When point 5 is evaluated, point J is placed in the I cluster. The evaluation of point J does not add any new points to the cluster since all points adjacent to J are already in the cluster.

Point 7 evaluation adds the last point P to the cluster. This subtraction method is a quick process for identifying adjacency.

After determining which points are in the cluster, a center or centroid of the cluster can be calculated. Since the data points are planar, then each cluster has a centroid that is defined by the mean values for X and Y within the cluster:

$$(\bar{X},\bar{Y}) = \left(\sum_{j=1}^{n} \frac{x_{j}}{n}, \sum_{j=1}^{n} \frac{y_{j}}{n}\right)$$

The centroids are now used as node points in the route selection process. The centroids are separated into two groups. If the centroid is for a low elevation cluster, it is placed in a low elevation array. Likewise, centroids for a high elevation cluster are placed in a high elevation array. The centroids in the high elevation array are identified by a minus sign. Figure 4.2 gives the location of the low and high elevation centroids that were found in the 10 by 10 km area utilized in the model development.

# 4.3 Sensor-Node Line of Sight

A major consideration in selecting a tactical aircraft route is to ensure that the route avoids enemy air defenses as much as possible.

To determine the degree of visibility along a route, each centroid has to have its line of sight (LOS) to each sensor determined. The result of this determination is an exposure value associated with each node point.

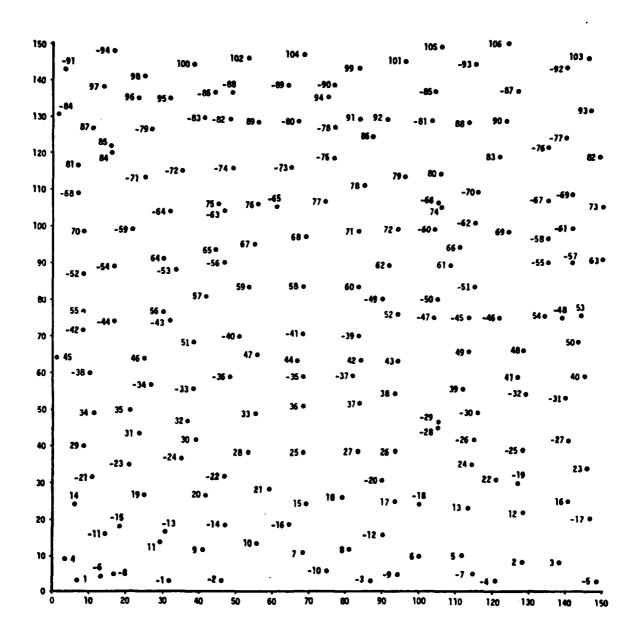


Figure 4.2 High and Low Nodes for Area One

To calculate the exposure value of a node point, the range between the node-sensor combination, together with the number of sensors, is required. The further a sensor is located from the node, the less of a threat it is since the probability of kill  $(P_k)$  is partially a function of range. However, the number of air defense sites having visibility to a point will increase the  $P_k$ . Since the sensors will tend to be deployed behind and along the general flow of the main battleline, an average range to sensors was selected as an exposure value. The exposure value is given by:

$$EP = NS \cdot \begin{bmatrix} R_{max} - \frac{S=1}{NS} \\ R_{max} \end{bmatrix}$$

where EP = the exposure value for node j with all sensors that have LOS with this node,

NS = the number of sensors that have LOS with node j,

R = the maximum node-sensor separation that exists for all node-sensor combinations,

 $R_{S,i}$  = the distance between the sensor and node j.

The value EP is calculated for all node-sensor combinations for both high and low elevation. As the route is being developed, the exposure values for the nodes are used as part of a penalty function. This discussion of the route selection is deferred to the next section.

For large areas of terrain, the data base has to be analyzed in segments or subareas that remain within computer core capacity. To satisfy

this restriction requires a bookkeeping method of array pointers to record the progress of the LOS calculations and which node-sensor pairs have been completed.

Referring back to Figure 3.6, the partition of the terrain data base is shown. Figure 4.3 presents the basic planar relationship between two nodes and a sensor. The + indicates the boundaries between each array of 15 by 15 terrain data points. Within this base the terrain elevation points represent X - Y coordinates of a square grid system. The vector between the node and sensor will intersect these grid lines and the array boundary lines. Along the X-axis the array boundary lines are also the map sheet boundary lines. Each intersection point of the vector and grid line is within 35 meters of a known elevation point. This known point is checked for masking of the node from the sensor. If masking occurs, the processing of this vector (or radial line as it is called in the air defense literature) is complete and the next node-sensor combination is processed [15]. If LOS exists at this intersection point, then the routine steps out of the vector to the next intersection. When the sensor location is reached and no masking terrain point has been encountered, then LOS exists between the node point and the sensor. The number of sensors which can see this node is then incremented by one.

To know which terrain point is along the LOS vector, the array indices are calculated from the vector-grid line intersection. The map sheets are read from west to east; therefore, all node-sensor vectors are oriented from west to east to allow one pass through all the data. In the model, the map sheet boundaries are named after the compass directions -

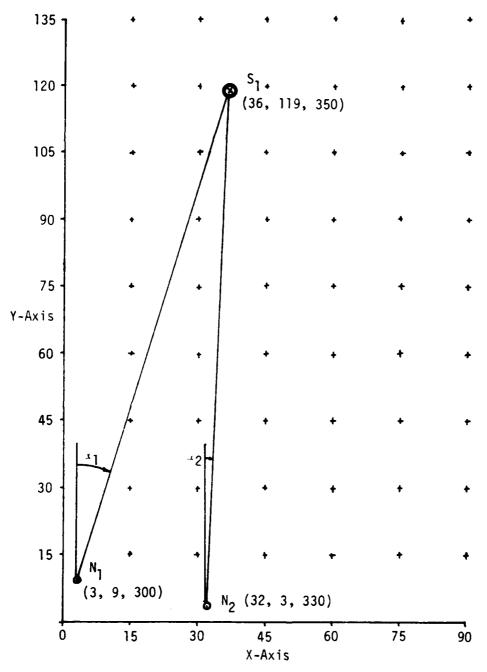


Figure 4.3 Sensor-Point Locations (X, Y, Z)

EAST, WEST, NORTH and SOUTH. As each map sheet is read, the previous EAST becomes the current WEST.

In Figure 4.3 the node point  $N_1$  (3, 9, 300) and sensor location  $S_1$  (36, 119, 350) define the end points of the vector  $N_1$   $S_1$  with an azimuth angle  $\alpha_1$ . The other node-sensor vector is  $N_2$   $S_1$  with an azimuth angle  $\alpha_2$ . The location of terrain points along these vectors becomes a trigonometric problem. The parameters defined below provide the indices needed to extract the terrain points from the data base.

$$d = \left[ (x_2 - x_1)^2 + (y_2 - y_1)^2 \right]^{\frac{1}{2}}$$

$$\cos \alpha = (y_2 - y_1)/d$$

$$\sin \alpha = (x_2 - x_1)/d$$

$$Comp x = \begin{cases} 1, & x_1 < WEST \\ (x_1 - West) + 1, & x_1 > WEST \end{cases}$$

Left Comp 
$$y = \begin{cases} \cos \alpha & ((WEST-X_1)/\sin \alpha), x_1 < WEST \\ 0, x_1 > WEST \end{cases}$$

where: d = the magnitude of the vector,

 $\cos \alpha$  = the cosine of the azimuth angle,

 $\sin \alpha$  = the sine of the azimuth angle,

Comp x = the x-axis component of the vector within the map sheet,

Left Comp y = the y-axis component of the vector for the West boundary.

From these parameters the row and column indexes can now be determined. For a vector, the indices are given below.

$$\begin{array}{l} \text{COLUMN} \ = \ \left\{ \begin{array}{l} x + \Delta x & , & |\sin\alpha| > \sin 45^0 \\ (\Delta y / \cos \alpha) \sin \alpha + x & , & |\sin\alpha| < \sin 45^0 , x > \text{WEST} \\ (x - axis) & (\Delta y / \cos \alpha) \sin \alpha + x - \text{WEST+1}, & |\sin\alpha| < \sin 45^0 , x < \text{WEST} \end{array} \right.$$

ROW = 
$$\begin{cases} y + \Delta y & \text{, } |\sin\alpha| < \sin 45^{\circ} \\ (\Delta x / \sin\alpha) \cos\alpha + y & \text{, } |\sin\alpha| > \sin 45^{\circ} \end{cases}$$

The final value of the row index has to be transformed to indicate which array on the map sheet is the correct one. Thus, the final row index is given by integer arithmetic.

ARRAY = 
$$(ROW - 1)/15$$
  
 $ROW = ROW - (ARRAY-1)(15)$ 

The terrain data located at (ROW, COLUMN, ARRAY) is checked to determine if its elevation will block the LOS. If it does not mask the node, the indices are incremented to the next value to be evaluated. After all node-sensor combinations have been processed, the route development can begin.

# 4.4 Route Selection.

With the node points for a route and their visibility determined, the method for linking these nodes into a route can be finalized.

Two other characteristics of a node need to be considered along with its visibility. The first is its elevation in relation to surrounding nodes and the second is the distance to these surrounding nodes.

To determine the area size that should be considered a neighborhood about a node, several military helicopter pilots were contacted to discuss terrain following or nap of the earth flying. These pilots unanimously report that a range of one kilometer is utilized to consider their next position. Even though major terrain features used for reference points can be seen several kilometers away, terrain following flights require a pilot to concentrate on the immediate area to avoid terrain impact. Therefore, one kilometer was selected as the rectilinear distance about a node to define a neighborhood.

Depicting the relationship of nodes in a neighborhood, Figure 4.4 contains the nodes surrounding nodes 13 and 17. These nodes are in the neighborhood of either 13 or 17. Table 4.2 lists these nodes, the co-ordinates, and the distance from the center (1 unit = 70 meters). The negative nodes are the high elevation centers and the positive nodes are the low elevation centers. As can be seen in Figure 4.4 and Table 4.1, five nodes are shared by nodes 13 and 17.

With this information, a value can be assigned to these neighborhood nodes based on their elevation and distance from the primary node. The higher elevation nodes would normally be avoided in favor of traveling to a low elevation node. A penalty for height is added to the exposure value of each node by the following factor.

$$ZP_j = \left(\frac{Z_j - Z_{min}}{ZR}\right)$$
  
where  $ZP_j =$  the penalty assigned to node j,  
 $Z_j =$  the elevation of node j,

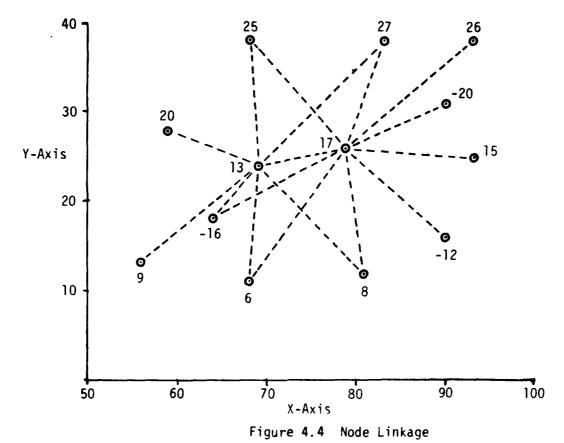


Table 4.2 Node Links

Node	13 (113, 23, 300)				
No.	(X,Y,Z)	Distance	No.	(X,Y,Z)	Distance
6 8 9 17	(100, 10, 300) (8, 10, 300) (41, 12, 300) (93, 25, 290)	13.038 16.971 17.029 10.198	20 25 27 -16	(42, 27, 290) (68, 8, 280) (83, 38, 280) (64, 18, 290)	10.770 14.036 19.799 7.810
Node 17 (93, 26, 290)					
No.	(X,Y,Z)	Distance	No.	(X,Y,Z)	Distance
6 8 13 15 25	(100, 10, 300) (81, 21, 290) (113, 23, 300) (69, 24, 280) (68, 38, 280)	18.601 14.142 10.198 14.036 16.279	26 27 -12 -16 -20	(93, 38, 280) (83, 38, 280) (70, 16, 300) (64, 18, 290) (90, 31, 290)	18.439 12.649 14.866 17.000 12.083

 $Z_{min}$  = the minimum elevation of the neighborhood nodes,

ZR = the range between the maximum and minimum elevation in the neighborhood.

$$0 \le ZP_{j} \le 1$$

To account for distance from the central node, the penalty is associated with traveling short distances rather than long distances. The idea is to travel as far as possible in the neighborhood to reach a low, least exposed node. Thus the distance factor is given by:

$$DP_{j} = \left(1 - \frac{D_{j} - D_{min}}{DR}\right)$$

where  $DP_j$  = the penalty for a short distance between the central and neighborhood node,

 $D_{j}$  = the distance to the neighborhood node j,

 $D_{\min}$  = the minimum distance,

DR = the range between the maximum and minimum distance in the neighborhood.

$$0 \le DP_{j} \le 1$$

Adding these two factors to the exposure value results in the following function.  $\begin{bmatrix} S & S \\ S & S \end{bmatrix}$ 

ction.

$$EP(ij) = NS \cdot \begin{bmatrix} R_{max} - \sum_{S=1}^{R} R_{Sj} \\ \frac{NS}{R_{max}} \end{bmatrix} + \begin{bmatrix} \frac{Z_j - Z_{min}}{ZR} \end{bmatrix} + \begin{bmatrix} 1 - \frac{D_j - D_{min}}{DR} \end{bmatrix}.$$

The linkage (ij) is from node i to node j for which j is the minimum value within the neighborhood. Since each point and neighborhood is considered independently of any previous neighborhoods, this method is a dynamic programming approach to solving this problem.

The route objective is to provide a path to the terminal position. Therefore, some weighting should be given to those nodes which lie in the general direction of travel. To implement this idea, the vector-heading from the current position to the terminal node is found. The nodes which lie within 90° of either side of this heading have a weight of 1. Those nodes greater than 90° are located behind the current position and have a weight of 2. The exposure penalty of a neighbor-hood node is multiplied by this weight to give preference to those nodes which are ahead of the current position. If a position behind the current one has a very low exposure penalty it can still be selected, but the route procedure will reorient to the terminal node and will favor the destination direction.

When the route model has reached a position within 1 km of the terminal node the weighting scheme is modified to be more selective. The angle of preference is reduced to 45° of the route heading and pertains to those nodes lying inside the 1 km range. The weighting schemes for the selection process are given in Figures 4.5 and 4.6.

In developing the model, it was found that these weighting schemes lack one vital criterion - radar avoidance. The first two weightings provide the model with decision logic which improves the performance considerably; however, if the minimum exposure point was located on the other side of a sensor, then the logic would still choose this same point even though the route would then be directly over the sensor. After some testing of the model, a radar avoidance scheme was added to the weighting preference.

Air defense radars usually will have an acquisition range greater than the engagement range of the weapon system (guns or missiles). An

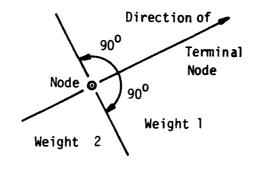


Figure 4.5 Weighting of Heading

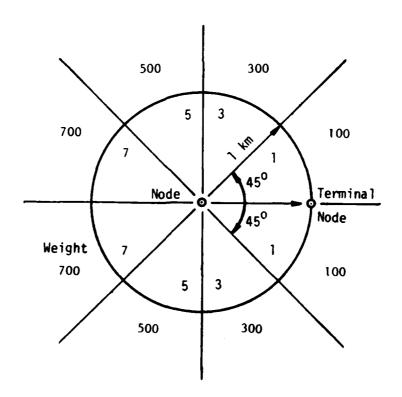


Figure 4.6 Weighting of Terminal Node

engagement boundary around the air defense site is assumed to be the weapon's kill radius. A vector from the current position to the sensor is calculated to give the azimuth and range to the sensor. A cone is used to form a high rejection area for nodes. The current position is the apex of the cone and the base is twice the kill radius, with the sensor at the base midpoint. A neighborhood node lying in this cone and ahead of the kill zone has a weight of 2. If it lies beyond this boundary the weight is 10. A node point which would cause the route to overfly or pass too close to the air defense site is thus avoided.

Figure 4.7 shows the relationship between the current node and the sensors, the terminal node and the new node. The angles shown in the figure are utilized in calculating the weighting values. Integer arithmetic allows a uniform weight to be assigned within any one area. The equations for calculating these weightings follows.

Angle of new node j from destination heading is:

$$ANT = \begin{cases} AN_{j} - AH & , -180^{\circ} \le ANT \le 180^{\circ} \\ AN_{j} - AH + 360^{\circ}, & ANT < -180^{\circ} \\ 360^{\circ} + AH - AN_{j}, & ANT > 180^{\circ} \end{cases}$$

Direction Weight is:

$$W_j = |ANT|/90^\circ + 1$$

Terminal Weight is:

$$RW_{j} = \begin{cases} 2|ANT|/45^{\circ} + 1 & , < 1 \text{ km} \\ (2|ANT|/45^{\circ} + 1) & 100 & , > 1 \text{ km} \end{cases}$$

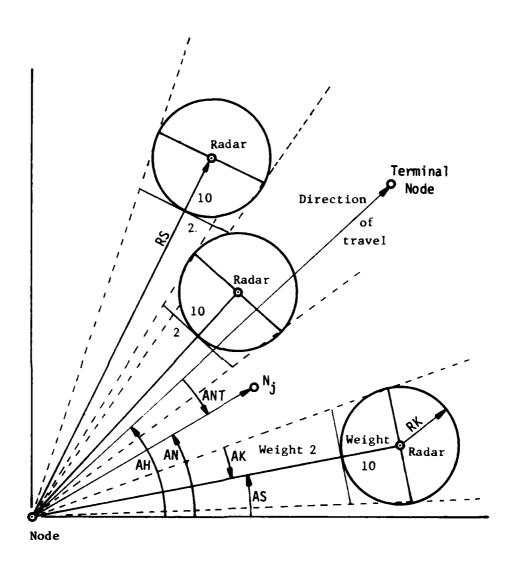


Figure 4.7 Radar Avoidance Weighting

Radar Avoidance Weight is:

$$AW_{j} = \begin{cases} 0, & AS - AN_{j} > AK \\ 2, & RN_{j} > RS - RK, AS - AN_{j} < AK \\ 10, & RN_{j} < RS - RK, AS - AN_{j} < AK \end{cases}$$

Where the variables in the equations and Figure 4.7 are:

 $AN_j$  = the angle from the x-axis to the new node j,

AH = the angle from the x-axis to the terminal node,

ANT = the angle between the new node and the terminal node,

AS = the angle to the sensor from the x-axis,

AK = the angle to each side of the sensor heading which would be within the kill radius,

RS = the range to the sensor from the current route node,

RK = the kill radius of the weapon system,

 $RN_{ij}$  = the distance to the new node j,

The final exposure penalty for a node is defined by:

$$N_k = \min_{j} (W_j + RW_j + AW_j) \cdot EP(ij)$$

Where  $N_k$  = the next node selected for the route,

 $W_i$  = the weight of node j based on its angle heading,

RW; = the weight of node j based on its range to terminal node,

AW = the weight of node j based on whether or not it lies in the radar avoidance cone.

# 4.5 Route Refinement

A review of the resulting routes as developed by the model indicates a need for route refinement; therefore, it is necessary for the route selection logic to evaluate whether or not route nodes are

adjacent to each other. In an attempt to avoid air defense sites, the route may double back on itself. Thus, the route must be refined by determining if each node j ahead of the current position i is the closest one. If, for example, the ninth route node ahead of the current one is the closest position, then that node becomes the next node to link with node i. Node i is linked to node j by the following relation.

$$L(ij) = \min_{j} [(x_{j} - x_{i})^{2} + (y_{j} - y_{i})^{2}]^{\frac{1}{2}}$$

$$j = i + 1, \dots, n$$
where
$$L(ij) = \text{the link between i and j},$$

$$(x_{j}, y_{j}) = \text{the current node position},$$

$$(x_{j}, y_{j}) = \text{the next node position}.$$

With this refinement to the model route logic, a shorter more direct route to the destination can be found. With the model development complete, an example will be given in the next chapter.

## CHAPTER V

# ROUTE SELECTION EXAMPLE

## 5.1 Introduction

The model is now utilized in selecting a route. The example described in this chapter is a portion of a route found by the model. Additional route problems that were solved by the model are contained in Appendix A. The general computer outline of the model and each subroutine is given in Appendix B. In addition the model software is commented throughout for ease in understanding the logic.

The area of analysis is 10 by 10 km. This size area is large enough to exercise the model yet small enough to run in 30 CPU seconds (6.5 seconds compile, 23.04 execution). The actual terrain is rolling hills with an elevation range from 270 to 400 meters. Within this area, 3 sensors are located to provide radar coverage.

Two positions were arbitrarily selected on opposite sides of the area as an initial and terminal node. These two positions are situated such that the three sensors are between these points. Any route found will have to consider node positions that lie near the sensors since they act as a barrier to be crossed.

## 5.2 Elevation Nodes

The initial part of the model provides the clustering of terrain data into high and low elevation groups. Within each group a center is found that becomes a node point for selection. The example clustering results were 106 low elevation nodes and 94 high elevation nodes.

Within the low elevation group, the initial and terminal nodes are inserted so that when the nodes are ordered by rows they will be in sequence. The first node is also the initial node. The terminal node is number 86. All high nodes are indicated by a minus sign.

# 5.3 Line of Sight Calculations

The amount of calculation required in identifying the nodes is minimal and consists mostly of comparisons and list searching. The first portion requiring any degree of computation is the LOS calculation in subroutine RADIAL.

For these calculations low elevation node 10 and high elevation node -11 were selected as examples for determining LOS. Two sensors will be used, as the calculations for more combinations are the same. The coordinates of the two nodes and sensors are given in Table 5.1.

Table 5.1 Node-Sensor Coordinates

Node (	(N <sub>i</sub> ) (X, Y, Z)	Sensor (R) (X, Y, Z)
10	(29, 14, 310)	1 (68, 70, 300)
-11	(12, 16, 330)	2 (47, 99, 310)

The first step performed by the model is to determine if the node or sensor is the western most point. Comparing X values in Table 5.1 indicates that both nodes are to the West of sensor 1. Node 10 will be analyzed first.

Table 5.2 gives the initial values for the variables used in this example. The horizontal scale is one unit equals 70 meters and the vertical values are in meters.

Table 5.2 Parameter Values

Map Sheet	2
EAST	30
WEST	16
SOUTH SOUTH	1
NORTH	150
Earth Curvature (RE) (radar 4/3)	8490200.0 meters
Vehicle Height (V) (Aircraft)	10.0 meters
Sensor Height (S) GRID	3.0 meters 70.0 meters

The first value needed is the horizontal distance between the node and the sensor.

$$d = [(x_2 - x_1)^2 + (y_2 - y_1)^2]^{\frac{1}{2}}$$

$$d = [(68 - 29)^2 + (70 - 14)^2]^{\frac{1}{2}}$$

$$d = 68.242$$

The azimuth angle cosine and sine are:

$$\cos \alpha = (y_2 - y_1) / d$$

$$\cos \alpha = (70 - 14) / 68.242$$

$$= 0.821$$

$$\sin \alpha = (x_2 - x_1) / d$$

$$\sin \alpha = (68 - 29) / 68.242$$

$$= 0.571$$

The tangent between these two points will determine whether the eastern point lies above or below the horizontal as measured from the western point. When calculating the tangent, the height of the vehicle and sensor are added to the appropriate point. In addition, the earth curvature for the radar beam atmospheric refraction is accounted for by the following relation [16].

The tangent is:

Tan 
$$\beta$$
 =  $((Z_R + S) - (Z_{N_i} + V) - REF)/(d)(GRID)$   
Tan  $\beta$  =  $(303 - 320 - 0.0192)/(68.242)(70)$   
=  $-0.0036$ 

The absolute value of  $\sin\alpha$  is compared to the sine of 45°. Since  $0.571 < \sin 45^\circ$ , then the direction is either north or south. The cosine is a positive 0.821 which indicates a north heading. When the cosine is negative, a south heading is indicated. The y position is found for the north or south direction by incrementing y by one plus any west boundary offset. In this example the Left Comp y is zero. The integer value of y is used for the data base row index and is found by integer arithmetic.

ROW = 
$$y + \Delta y$$
  
= 14 + 1 = 15  
ARRAY =  $(ROW - 1)/15 + 1$   
=  $(15 - 1)/15 + 1 = 1.93 = 1$   
ROW =  $ROW - (ARRAY - 1) (15)$   
= 15 -  $(1 - 1) (15) = 15$ 

The column position can be found by the following.

COL = 
$$(\Delta y/\cos \alpha) \sin \alpha + x - WEST + 1$$
  
=  $(1/0.821) (0.571) + 29.0 - 16 + 1$   
=  $14.70 = 14$ 

The position of the first point to be extracted from the data base is located at (ROW, COL, ARRAY) = (15, 14, 1) of the second map sheet. Now that the elevation of 308 has been found at this point a tangent is calculated to determine if this new point masks node 10 from sensor 1. The distance to the new point, d', is given by:

Tangent  $\alpha$  for the new point is calculated by:

Tan 
$$\alpha$$
 =  $(Z_n - (Z_i + V) - Ref')/(d')(GRID)$   
where  $Z_n$  = the elevation of the new point.  
Tan  $\alpha$  =  $(308 - 320 - 0.000006)/(1.22)(70)$   
=  $-0.14$ 

Since  $\tan \alpha < \tan \beta$ , this new point does not mask the node (-0.14<-.0036). The value of y is incremented to find the next grid point to be extracted from the data base.

$$y = 2$$

ROW = 14 + 2 = 16

ARRAY = (16 - 1)/15 + 1 = 2

ROW = 16 - (2 - 1) (15) = 1

COL = (2/0.821) (0.571) + 29.0 - 16 + 1

= 15.39 = 15

The second point from the data base is located in position (1, 15, 2) (Z = 304). Since the column is equal to 15, the eastern edge of the map sheet has been reached. In this case this second point does not mask the node, but any further calculations have to wait until the third map sheet is read into core storage.

The second node, number -11, is located on map sheet 1. Since this example began on map sheet 2, then the procedure for starting on the second map sheet, where the first map sheet processing stopped, will be shown. The basic calculations of sine, cosine, etc. are similar and are given below:

$$d = [(68 - 12)^{2} + (70 - 16)^{2}]^{\frac{1}{2}}$$

$$= 77.795$$

$$\cos \alpha = (70 - 16)/77.795$$

$$= 0.694$$

$$\sin \alpha = (68 - 12)/77.795$$

$$= 0.720$$

$$Ref = 0.5 (77.795)(77.795)/(121288.57)$$

$$= 0.0249$$

$$\tan \alpha = (303 - 340 - 0.0249)/(77.795) (70)$$

$$= -0.0068$$

In this case,  $\sin \alpha > \sin 45^\circ$ ; thus the direction is east. For a easterly vector the value of x is incremented by one to find the next position, but the value of y is calculated. Since x < WEST, x and COL are set to 1. The row index of y is calculated by

ROW = 
$$(\Delta x/\sin \alpha) \cos \alpha + y$$
  
=  $((16 - 12 + 1)/ 0.720) 0.694 + 16$   
=  $20.82$ 

ARRAY = 
$$(ROW - 1)/15 + 1$$
  
=  $(20.82 - 1)/15 + 1 = 2$   
ROW =  $ROW - (ARRAY - 1) (15)$   
=  $20.82 - (1)(15) = 5$ 

The first position in the second map sheet for node -11 is (5, 1, 2). The tangent of this new point is calculated the same as shown for node 10. The tan  $\alpha$  < tan  $\beta$  in this case; therefore, the next position on the vector is found and checked for LOS.

The result of these computations is the number of sensors which can see this node. Having obtained this count on each node-sensor combination the exposure value for the node can be computed. For node 10 the count is 3, since all sensors can see this node. The  $R_{\text{max}}$  value for the node-sensor combinations in this example was found to be 161.941. The sum of the distances to the three sensors is 252.589. The exposure value is:

EP = NS · 
$$\begin{bmatrix} R_{max} - \frac{NS}{S} & R_{Sj} \\ R_{max} - \frac{S=1}{NS} & \frac{R_{Sj}}{NS} \end{bmatrix}$$
= 3 · 
$$\begin{bmatrix} 161.941 - \frac{252.589}{3} \\ 161.941 \end{bmatrix}$$

= 1.440

#### 5.4 Route Selection

For the route selection method, the initial point and the next to last point along a route were chosen as examples. The initial point is

also node 1 (7, 3, 270) and the terminal point is node 86 (87, 124, 310). Starting at node 1, the route seeks the minimum exposure point in the neighborhood. The nodes surrounding node 1 are given in Table 5.3.

Node	(x, y, z)	Distance	Exposure Value						
4	(3, 9, 300)	7.211	0.672						
-6	(13, 4, 400)	6.083	1.122						
8-	(17, 5, 400)	10.198	1.167						
-11	(12, 16, 330)	13.928	1.310						

Table 5.3 Neighborhood Nodes

The distance and height penalties are now added to the exposure value for these points. The height penalty is given as:

$$ZP_{j} = \frac{Z_{j} - Z_{min}}{ZR}$$

$$ZP_{4} = \frac{300 - 300}{100} = 0.0$$

$$ZP_{-6} = \frac{400 - 300}{100} = 1.0$$

$$ZP_{-8} = \frac{400 - 300}{100} = 1.0$$

$$ZP_{-11} = \frac{330 - 300}{100} = 0.3$$

The distance penalty is:

$$DP_{j} = 1.0 - \left(\frac{D_{j} - D_{min}}{DR}\right)$$

$$DP_{4} = 1.0 - \left(\frac{7.211 - 6.083}{7.845}\right)$$

$$= 1.0 - 0.144 = 0.856$$

$$DP_{-6} = 1.0 - \left(\frac{6.083 - 6.083}{7.845}\right)$$

$$= 1.0$$

$$DP_{-8} = 1.0 - \left(\frac{10.198 - 6.083}{7.845}\right)$$

$$= 1.0 - 0.525 = 0.475$$

$$DP_{-11} = 1.0 - \left(\frac{13.928 - 6.083}{7.845}\right)$$

$$= 1.0 - 1.0 = 0.0$$

The final penalties associated with these nodes are:

The direction weighting of these penalty values are determined by computing the azimuth of the terminal and neighborhood nodes. Table 5.4 gives the azimuth angle to the nodes, their weight and their final penalty value.

Table 5.4 Weighted Penalty Value

From	То	Angle x-axis	Angle from Heading	Weight	Penalty
1	86	56°	0°	-	-
1	4	123°	67°	1	1.528
1	-6	9°	-47°	1	3.122
1	-8	11°	-45°	1	2.642
1	-11	68°	12°	2	3.220

To compute the Table 5.4 entries for node 4 the following values are found using integer arithmetic.

$$x-axis AN_4 = ARCTAN (Y/X)$$
  
= ARCTAN ((9-3)/(3-7))  
= -56.31°

Since the angle is negative, it is subtracted from 180°.

AN<sub>4</sub> = 
$$180^{\circ} - 56.31^{\circ} = 123.69^{\circ} = 123^{\circ}$$
  
ANT =  $123^{\circ} - 56^{\circ} = 67^{\circ}$   
Weight W<sub>j</sub> = ANT /  $90^{\circ} + 1$   
=  $67^{\circ}/90^{\circ} + 1$   
=  $0 + 1 = 1$   
Penalty EP<sub>ij</sub> = (W<sub>j</sub>) (EP<sub>j</sub>)  
= (1)(1.528) = 1.528

Node -11 is the only one in Table 5.4 that utilized the radar avoidance weighting. Sensor 2 is almost collinear with nodes 1 and -11. For this example, the weapon system kill radius is 1.5 km or 21.43 in units of 70 meters. The calculations below would be made for all sensors and all nodes in the neighborhood, however, only node -11 is affected in this case.

Angle to sensor 2 is given by:

x-axis 
$$AN_{-11} = ARCTAN (Y/X)$$
  
=  $ARCTAN ((99 - 3)/(47 - 7))$   
=  $67.38^{\circ} = 67^{\circ}$ 

Angle of 1/2 cone is given by:

RS = 
$$[(99 - 3)^2 + (47 - 7)^2]^{\frac{1}{2}}$$
  
= 104.00  
AK = ARCTAN (21.43/104.00)  
= 11.64°

Angle between sensor 2 and node -11 is given by:

AS - AP (from Table 5.4)  

$$-1^{\circ} = 67^{\circ} - 68^{\circ}$$
  
 $-1^{\circ} < 11.64^{\circ}$ 

Therefore, node -11 is in the cone of high rejection.

$$AW_j = 2$$
, distance node -11 < sensor 2 (13.9 < 104.00)

The next to last node along the route, number 78, utilizes the terminal weighting scheme. The values associated with node 78 are in Table 5.5. In this table the terminal node 86 has the smallest weighted exposure. The values in Table 5.5 are computed as shown previously except for the weight entry. The weight value for nodes 71 and 72 are found below.

For node 71:

$$RW_{j} = 2 \text{ ANT}/45^{\circ} + 1 , (13.153)(70) < 1 \text{ km}$$

$$= 2 (-179/45) + 1$$

$$= 2 (4) + 1 = 7$$

Table 5.5 Node 78

From	To	From To Distance Exposure	Exposure	Height Penalty	Height Penalty Distance Penalty Angle X-axis Heading Weight Penalty	Angle X-axis	Heading	Weight	Penalty
78	7.1	13.153	2.438	0.0	0.423	-98	-179°	7	5002
78	72	15.000	2.306	0.0	0.000	-53°	-134°	200	115500
78	79	11.180	2.234	0.0	0.874	10°	-11°	က	933
78	98	13.153	0.730	0.5	0.423	81°	0	_	163
78	-75	10.630	1.576	1.0	1.000	138°	57°	ю	1059

For node 72:

$$RW_j = (2 \text{ ANT}/45^\circ + 1) 100$$
 ,  $(15.0)(70) > 1 \text{ km}$   
=  $(2 (-134/45) + 1) 100$   
=  $(2 (2) + 1) 100 = 500$ 

# 5.5 Route Refinement

To provide an example of route refinement consider the following situation given in Table 5.6.

T	ab	1e	5.6	Linkage
---	----	----	-----	---------

From Node	(X, Y, Z)	To Node	(X, Y, Z)	Distance
31	(11, 45, 280)	30	(23, 43, 280)	12.166
30		28	(8, 40, 280)	15.297
28		35	(21, 50, 280)	16.401
35	-	34	(11, 49, 280)	10.050
34	_	45	(1,64,300)	18.028

The linkage between these points can be seen in Figure 5.1. From the figure, it is seen that node 34 is the closest node to node 31. The model determines this fact by comparing distances between nodes. The distance from node 31 to each of the nodes ahead of it is computed to the end of the route by the model; however, for this example, the process will stop at node 45. Table 5.7 gives the distance values for each of these nodes.

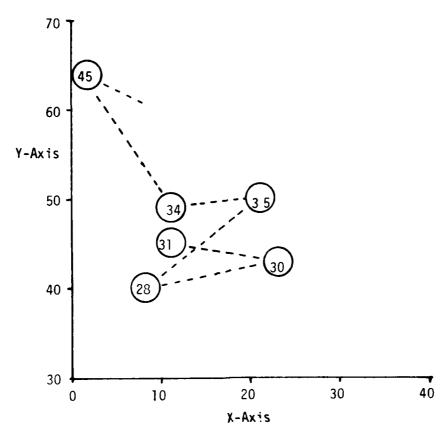


Figure 5.1. Linkage Example.

Table 5.7 Distance from Node 31

Node	Distance
30	12.166
28	5.831
35	11.180
34	4.000
45	21.471

The closest node to node 31 is node 34. In the refinement procedure, node 31 would be linked to node 34. Nodes 30, 28 and 35 would be eliminated from the route. The next node in the sequence, node 34, would now be compared with all nodes ahead of it for the closest node. The model continues to evaluate each new node on the route until the destination is reached. The results of this procedure become the refined route.

# CHAPTER VI

## MODEL RESULTS

# 6.1 Introduction

To evaluate the effect of sensor location on the route selection, two sets of sensor deployments were chosen along with two sets of beginning and end points. Since the test area was predominantly level terrain, a second small area was chosen of moderately rough terrain.

The results of the two small 10 by 10 km terrain areas are presented first, followed by the large 35 by 35 km area. To run the large terrain required increasing the dimensions of several primary arrays. The computer processing time for the large area increased by a factor of 10.

A plot of the route has proven to be the best analysis tool in evaluating the resulting routes. The tables provide the quantitative results; however, the route figures provide a visual comparison between routes that is discernible.

# 6.2 Small Area Analysis

The performance of this model was judged by varying sensor and route end points to provide different routes. Tables 6.1 and 6.2 provide the location of sensors and route end points utilized in the two small terrain areas. Each set of sensors was deployed against each route, resulting in four cases for each area as shown in Table 6.3.

Table 6.1 Sensor Locations

	Area	1		
	Set 1	Set 2		
Sensor 1 2 3	(X,Y,Z) (68, 70, 300) (36, 119, 350) (47, 99, 310)	Sensor (X,Y,Z) 1 (115, 116, 330) 2 (90, 84, 340) 3 (103, 45, 320)		
	Area	2		
Set 1		Set 2		
Sensor 1 2 3	(X,Y,Z) (28, 114, 330) (61, 90, 380) (78, 71, 350)	Sensor (X,Y,Z) 1 (78, 57, 350) 2 (85, 42, 340) 3 (100, 17, 320)		

Table 6.2 Initial and Final Route Points

			Area 1		
Route 1 2	Node 1 31	From (X,Y,Z) (7, 3, 270) (11, 45, 280)		Node 86 96	To (X,Y,Z) (87, 124, 310) (135, 135, 360)
			Area 2		
Route 1 2	Node 3 35	From (X,Y,Z) (26, 4, 350) (11, 50, 300)		Node 81 84	To (X,Y,Z) (118, 111, 310) (128, 114, 320)

Table 6.3 Route Cases

Case	Area	Route	Sensor Set
1	1	1	1
2	1	2	1
3	1	1	2
4	1	2	2
5	2	1	1
6	2	2	1
7	2	1	2
8	2	2	2

The initial point and the destination point are placed in the low elevation array with their node number within that array given in Table 6.2. Except for the initial and destination nodes, the set of high and low elevation nodes for an area is determined solely on elevation. They remain constant for all scenarios. Table 6.4 indicates 106 low elevation nodes and Table 6.5 indicates 94 high elevation nodes. Tables 6.6 and 6.7 give the exposure values of these nodes for the first set of sensors. These values will change with each sensor deployment and the number of sensors. The first entry in Table 6.6 corresponds to the first entry in Table 6.4 with the other values corresponding in the order given. Likewise, Table 6.7 entries correspond to the entries in Table 6.5 in the same manner. The data contained in these four tables provide the basic information required for the route selection.

The results of the route selection process for the first case is given in Table 6.8. The node linkage is from node i to node j with the

Table 6.4. Low Elevation Node Points

	_									
X-CCORDINATE	7	138	128	3	112	100	68	61	41	56
Y-COORDINATE	3	8	8 300	300	10	10	11	12	12	13
Z-CGORDINATE	270	300	300	200	308	300	290	290	300	290
X-COOPEINATE	29	128	113	6	69	141	93	79	25	•2
Y-COORDINATE	14	22	23	24	24	25	25	26	27	27
Z-CCORDINATE	310	303	3 6 0	300	280	300	250	2 0 0	300	290
X-CCCRDINATE	50	121	146	112	€8	93	83	53	8	39
Y-COORCINATE	28	31	34	35	3.8	38	38	36	40	42
Z-COORCINATE	2 6 0	300	300	390	280	280	260	580	280	280
X-CCORDINATE	23	37	55	11	21	60	e 3	93	112	145
Y-COORDINATE	43	47	49	45	50	51	52	54	5.5	<b>£</b> 9
Z-COGRGINATE	280	280	280	280	260	280	260	560	300	300
X-COORE INATE	127	84	94	67	1	25	56	128	113	143
Y-CCORDINATE	5.5	63	63	63	64	64	65	66	66	68
Z-COORDINATE	31"	290	250	290	300	300	2 <b>5</b> C	300	360	300
X-CCCRDINATE	36	94	144	134	8	30	42	68	53	83
Y-CCOPDINATE	6 -	76	76	76	77	77	81	83	63	83
Z-CGCRDINATE	300	300	300	310	340	316	300	300	300	300
X-CGORDINATE	138	92	150	3 a	44	111	55	69	124	
Y-COORDINATE	99	85	91	91	5.3	94	9.5	97	5.0	58
Z-CCORDINATE	33¢	300	360	330	310	330	300	300	350	350
X-COGRDINATE	33	94	150	106	45	56	73	85	56	166
Y-CCORDINATE	96	99	105	105	106	106	107	111	113	114
Z-CCORCINATE	3 0 0	300	360	336	330	326	300	300	300	310
X-COORCINATE	7	145	122	16	16	97	11	113	57	123
Y-COORDINATE	117	119	119	120	122	124	127	128	12#	129
Z-COORDINATE	300	346	330	36 C	3 6 6	31C	300	330	330	336
X-COORDINATE	å£	91	147	75	32	23	14	25	83	38
Y-COORDINATE	129	129	132	135	135	135	127	141	143	144
Z-CCOPDINATE	300	300	330	310	310	300	300	300	300	366
X-CCGRDINATE	96	53	146	65	106	124				
Y-CCCRCINATE	145	146	146	147	145	150				
Z-CCGRDINATE	300	300	320	306	300	320				

AUPPER OF NODES 10

Table 6.5. High Elevation Node Points

X-CCORDINATE	32	46	€7	121	149	13	115	17	94	75
Y-CCORDINATE	3	3	3	3	3	4	5	5	5	6
Z-CCORDINATE	330	310	300	310	330	400	310	408	310	300
X-COORDINATE	12	90	31	47	18	64	1+7	100	127	90
Y-CCCRDINATE	16	16	17	18	18	18	20	24	30	31
Z-CGORDINATE	330	300	310	300	330	290	310	300	320	290
A-CCCRDINATE	11	47	21	35	128	115	141	105	105	116
Y-CCORDINATE	32	32	35	37	39	42	42	4.5	46	49
Z-CCORDINATE	290	290	300	290	339	330	330	330	320	330
X-CGCPDINATE	140	129	38	27	6.6	46	62	10	83	51
Y-CCOFEIRATE	53	54	56	5.7	55	59	59	6 C	70	70
Z-COORDINATE	330	330	300	300	250	300	250	316	360	300
X-COCPDINATE	6.5	8	32	17	113	122	104	139	90	105
Y-COORDINATE	71	72	74	74	75	75	75	75	0.9	80
Z-COORDINATE	300	330	310	330	340	330	330	310	310	340
>-CCCRSINATE	115	8	33	17	125	47	142	135	22	104
Y-CCORCINATE	e.3	67	8.8	89	50	90	90	97	99	99
Z-COORDINATE	350	250	330	35(	370	310	390	• 60	350	330
>-COCRDINATE	142	115	47	32	61	105	135	9	142	116
Y-COORDINATE	99	101	104	104	105	106	107	107	108	109
Z-CCOPCINATE	400	250	330	350	320	330	350	35 C	400	350
X-COORDINATE	25	35	65	49	77	135	140	77	27	67
Y-COOPDINATE	113	115	116	116	118	122 .	124	127	127	128
2-COORDINATE	350 .	350	330	340	353	350	350	320	350	330
X-CCCFDINATE	103	48	91	2	104	••	127	49	64	77
Y-COORDINATE	129	129	130	131	137	137	137	137	138	138
Z-COGPCINATE	330	350	350	380	330	346	340	340	330	310
X-CCORDINATE	3	140	115	17						
Y-COOFDINATE	143	143	144	148						
2-COGROTAATE	380	330	330	340						

NUMBER OF NODES 94

	.825						
		.672	1.039	1.160	1.301	1.339	1.405
	1.217	1.390	1.612	000.0	1.465	1.595	1.587
	00000	1.390	1.866	1.666	1.766	1.892	0.000
	1.400	0.000	000.0	2.095	1.984	1.283	1.624
	1.970	2.307	000.0	1.477	2.347	•629	1.688
	000.0	0.000	1.315	1.590	1.710	2.459	2.526
	0.000	1.555	.1.753	1.811	2.582	2.452	1.579
	00000	1.874	2.594	2.548	1.601	1.480	1.596
	066.	0.000	000.0	.647	0.000	1.623	1.494
	.310	0.000	0.000	0.000	0.000	0.000	0.000
	.361	00000	. 530	• 424			
Table 6.7. Exposure	re Values	for High	Elevation	Nodes			
1.214 1.253	1.149	. A 36	.486	1.122	. 932	1.167	1.129
	1.454	1.526	1.390	1.520	000.0	1.380	.214
	1.665	1.815	.625	1.433	1.034	1.610	1.622
	2.135	2.060	2.213	2.234	2.056	.637	2.203
	2.317	.6A4	1.739	.665	1020	00000	2.149
	2.455	1.445	1.4.85	2.574	1.259	1.384	1.513
	2.607	1.598	2.509	1.687	1.366	.818	1.239
	1.525	2.505	1.445	.827	.762	1.386	1.492
	1.519	1.222	1.096	. E 7 B	1.129	.863	164.
101.	. 447	. 786					

	Table	6.8. NODE	LINKAGE	FOR ROUTE		
ر. در	EASTING	NORTHING	10	PENALTY	EASTING	NORTHING
	σ,	21	4	3	-	6.3
4		63		Ĵ	19	35
æ I	19	35	11	æ	0.3	9
11	03	9		ت	87	4
ው	8	<b>4</b>		4	92	91
10	92	91		a:	8	68
15	<b>™</b>	8		7	8	99
27	81	5		Ý.	51	99
5.E	51	99		~	35	022
-29	3	022		4	48	052
64.	4	092		7	91	162
4 9	91	62		3	96	162
<b>4</b>	3968	11620	4.0	о. 10)	9826	12250
-48	73	225		c	0.08	232
ις. ευ	000	232		1	050	337
63	5.0	k:		27	50	4 35
t.	0.50	435		La	043	(A)
æ	043	533		96	029	624
o. W	029	624		N	0.22	722
103	025	722		iD	54	533
(►) (L	3	E) (H)		228	91	596
œ *	51	596		<b>*</b> )	28	629
प द 1	c.	6 u 3	C.	77	49	666
O	9	<b>£66</b>		16	60	568

Table 6.9. Node Linkage

NCCE NC.	1 TCTA	L LINKS	4				
X.Y.Z CCORCI LINMED TO EXPCSURE WEIGHTED	NATE	7.	3. 270				
LINKED TO	4	-6	- A	-11			
EXPOSURE	162	111	243	160			
HETCHTER		3.1	203	100			
8610-150	195	215	264	322			
NGDE NO.	A TOTAL	L LIAKS	5 5• 300				
N.Y.Z COORCI	NATE	3.	5. 300				
LINKED TO	14	-6	-11	-9	-15		
FRECSURE	172	311	367	262			
UE I CHIEFE		344	2.,		168		
NODE ROS X-Y-Z COORCI LINHED TO EXPCSURE WEIGHTED	348	212	219	263	338		
NCDE NO	LATOT S	LLINKS	6				
X.Y.Z COORCI	NATE	17.	5. 400				
LINKEE TO	11	-6	-11	-15	-1	-13	
EXPOSURE	163	111	197	198	166	145	
N.Y.Z COGRETS LINKED TO EXPOSURE WEIGHTED	164	430	100	176			
BETA-IED	76-	654	148	398	167	252	
NOCE NC. 1	1 TOTAL	LLINKS	6				
X.Y.Z CCORCI	NATE	25 • 1	4. 310				
LINKES TO	9	19	20	-13	-1	-15	
EXPOSURE	276	215	167	294	266	261	
X+Y+Z CCORDINATED TO EXPCSURE WEIGHTED	207	214	114	590			
AP TOLIED	e u 1	¢ 1 b	236	370	534	564	
MUUL KO.	TOTAL	LINKS	5				
X+Y+Z COORCI	STAN	41. 1	2. 300				
NODE NO.  X+V+Z COORCI  TO T	10	-14	-2	-13	-1		
EXPOSURE	144	277	246	253	254		
WE IGHTED	145	274	484	254	510		
	4-4	2.0	474	234	210		
NCDE NO 14			_				
NCDE NO. 10	JUTAL	LINKS	7				
X . Y . Z COOREIN	I A TE	56 · 1	3, 290				
LINKED TO	7	21	15	2 G	-16	-14	-2
X.Y.Z COORDIN LINKED TO EXPOSURE WEIGHTED	244	214	167	199	-16 284	3 6 6	276
WEIGHTED	245	430	188	200	285	369	554
	-		•	200		30,	334
			_				
	TETAL	LINKS	7				
X . Y . 2 CCC= 214	TOTAL SATE	LINKS	7 290				
NOTOZ COCEZIN	TOTAL STE 18	LINKS 65: 24	7 • 290 7	25	é	27	-16
X+Y+Z CCC=CIN LINAEC TG EXPOSURE	121AL 18 18 219	LINKS 65. 24 21 246	7 • 290 7 285	25 239	£	27 176	-16
X+Y+Z CCC=CIN LINAEC TG EXPOSURE WEIGHTED	18 239 239 241	LINKS 65. 24 21 246 247	7 • 290 7 285	25 234	248	176	342
NCCE NC. 15 Novoz Cocedin Linaed TG Exposure Weighted							
					248	176	342
					248	176	342
					498	176 177	342 626
					248 498	176 177	342
					248 498	176 177	342 686 -20
					248 498	176 177	342 686 -20 349
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580		498	176 177	342 686 -20
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580		248 498	176 177	342 686 -20 349
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580		248 498	176 177	342 686 -20 349
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580	25 235 472	17 272 546	176 177 36 209 2100	342 686 -20 349 720
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580	25 235 472	17 272 546	176 177 36 209 2100	342 686 -20 349 730
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580	25 235 472	17 272 546	176 177 36 209 2100	342 686 -20 349 720
NODE NO. 27 X+Y+2 CCOFUIN LINKED TG EXPCSURE WEIGHTED	TCTAL ATE 26 265 266	LINKS 83+ 36 18 231 464	7 • 280 37 257 2580	25 235 472	17 272 546	176 177 36 209 2100	342 686 -20 349 730
NODE NO. 27 X+Y+2 CCOPUIN LIMED TG EXPCSURE WEIGHTED NCCE NC. 26 X+Y+2 CCCPUIN LIMES TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 434	LINKS 18 211 464 LINKS 93. 39 27 219 420	7 . 260 37 . 257 258c	25 235 472 -20 278	17 272 546	176 177 36 209 2100	-20 349 720
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	17 272 546	176 177 36 209 2100	-20 349 720
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	17 272 546	176 177 36 209 2100	-20 349 720
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -15 202 406
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCGFUIN LINKED TO EXPESURE WEIGHTED  NCDE NC. 26 X+Y+2 CCGF2IN LIN-ES TO EXPCSURE BEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424	LINKS 83. 36 231 464 LINKS 93. 35 17 219 420	7 . 260 37 257 258c . 28C . 18 159 320	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -15 202 406
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302 -26 253 588	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	17 272 546 -28 301 302 -26 253 588	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	248 498 17 272 546 -28 301 302 -263 588	176 177 36 209 2100 -29 277 278	342 626 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 26 265 266 TCTAL ATE 17 216 424 TOTAL ATE 11 39 246 247	LINKS 83. 36 281 464 LINKS 93. 36 27 229 LINKS 05. 46 28	7 . 260 37 257 2586	25 235 472 -20 278 558	17 272 546 -28 301 302 -26 253 588	176 177 36 209 2100 -29 277 278	342 626 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 434  TOTAL ATE 19 246 247  TOTAL ATE 11 424 424 424 424 424 424 424 424 424	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -263 588	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -263 588	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -263 588 -263 508	176 177 36 209 2100 -29 277 278	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -263 588 -263 508	176 177 36 209 2100 -29 277 278 -30 295 296	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -253 588 -253 508 -47	176 177 36 209 2100 -29 277 278 -30 295 296	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCOFDIN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LIN+ED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN UEIGHTED  NODE NC. 39 X+Y+2 CCCFDIN LINKED TO X+Y+2 CCCFDIN X+Y+2 CCC	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 101 202 -253 588 -253 508 -47	176 177 36 209 2100 -29 277 278 -30 295 296	342 686 -20 349 700 -16 202 406 -20 179
NODE NO. 27 X+Y+2 CCC+UN LINKED TO EXPESURE WEIGHTED  NCCE NC. 26 X+Y+2 CCC+UN LIN+EC TO PYPOSURE BEIGHTED  NCCE NC29 N+Y+2 CCC+UN LINKED TO EXPCSURE WEIGHTED	TCTAL ATE 265 266  TCTAL ATE 17 216 439  TOTAL ATE 19 246 247  TOTAL ATE 11 429 241 241 242	LINKS 18 28 28 464 LINKS 93. 17 219 420 LINKS 05. 46 218 418 LINKS 12. 56 172 146	7 , 200 37 257 258c 7 , 28c 18 159 320 7 , 320 36 161 324 5	25 235 472 -26 278 558 -29 559 720	248 498 17 272 546 -28 301 302 -253 588 -253 508 -47	176 177 36 209 2100 -29 277 278 -30 295 296	342 686 -20 349 700 -16 202 406 -20 179

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140		u.					•	

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		LINKS	8							
ICROOD S.Y.K			6. 300							
LINKEC TO	41	54	50	-46	-32	-48	-45	-31		
EXPCSURE	264	<b>e 1</b>	77	504	255	57	273	187		
WEIGHTED	530	52	156	205	52C	58	546	376		
NODE NO4	TOTAL	LINKS	•							
X.Y.Z C00501										
LINKED TO	53	54	50	-55						
		114	125	237						
EXPCSURE	100									
WE IC + TED	505	230	252	236						
			_							
	3 TOTAL		5							
X.Y.Z COOSCI	NATE 1	44. 7	6, 300							
LINKED TO	50	54	63	-57	-55					
EXPOSURE	163	÷ 8	71	253	215					
WEIGHTED	308	69	72	254	216					
••••										
NCDE NC. 6	3 TOTAL	LINKS	5							
X+Y+Z CCOPGI										
LINFER TO		-57	-61	-55	-58					
EXPOSURE	26	299	283	176	235					
WEIGHTED	27	£30	284	354	472					
			-							
	3 197AL		7							
X+Y+2 COOPEI										
LINKED TO	65	-69	-61	-67	-58	-57	5			
EXPOSURE	56	322	312	266	270	241	167			
WEIGHTED -	57	323	313	534	542	242	100			
NODE NO. 6	2 TOTAL	LINKS	5							
X.Y.Z CCORCI	4875 1	46. 11	C. SAC							
LINKES TO		7	,,,,,	-76	-67					
EXPOSURE	55	2:4	288	161	421					
		2								
WEIGHTED	a E	2:5	289	162	444					
			_							
	TOTAL		. <b>.</b>							
X.Y.Z COORCIS				_						
LINKEE TO		-77	-92	-76						
EXPOSURE	61	273	154	179						
UEIGHTED	124	548	155	360						
NOCE NC. 10	TOTAL	LINKS	5							
N.Y.Z COORDII										
LINKED TO		83	-92	-87	-77	-76				
EXPOSURE	171	98	170	231	216	210				
02TH013W		198	142	464	217	211				
#E 10 HIED	7 4 4									
	344	170		-6-	• •					
MODE LC 6				-6-	•••					
MODE NO. 6.	3 7074L	LINKS	5		••	•				
MAYAZ COORCII	3 TOTAL NATE 1	LINKS 22. 11	5 9. 33C							
N.Y.Z COORCI!	3 7074L 47E 1:	LINKS 22. 11 88	5 -73	-76	•67					
X.Y.Z COGRESS LIAKEE TO EMPOSUPE	3 TOTAL SATE 1. 50 245	LINKS 22. 11 88 227	5 9• 330 -70 280	-76 172	•67 234					
N.Y.Z COORCI!	3 7074L 47E 1:	LINKS 22. 11 88	5 -73	-76	•67					
N.Y.Z COORCI! LIAMEC TO EMPOSUPE BEIGHTEC	3 7074L NATE 1: 90 245 246	LINKS 22. 11 88 227 228	5 -70 280 261	-76 172	•67 234					
X.Y.Z COORCI! LIAKED TO EMPOSUPE BEIGHTED AODE NO. 81	3 TOTAL SATE 1: 50 245 246	LINKS 22. 11 28 227 228 LINKS	33C -70 280 261	-76 172	•67 234					
X.Y.Z COORCI! LIAKED TO EMPOSUPE BEIGHTED AODE NO. 81	3 TOTAL SATE 1: 50 245 246	LINKS 22. 11 28 227 228 LINKS	5 -70 -70 260 261 5	-76 172	•67 234	•				
N.Y.Z COORCI! LIAMEC TO EMPOSUPE BEIGHTEC	3 TOTAL SATE 1: 50 245 246	LINKS 22. 11 28 227 228 LINKS	5 -70 -70 260 261 5	-76 172	•67 234	•				
N.Y.Z COORCI/ LIMEE TO EVPOSUPE BEIGHTED MODE NO. E N.Y.Z CCCRCI: LINKED TO	3 TOTAL \$47E 1 50 245 246 E TOTAL \$47E 1	LINKS 22. 11 68 227 228 LINKS 11. 12	5 -70 -70 -260 -261 -5 -6, 339	-76 172 345	•67 234 •70	•				
Novoz Coorci Linker to Evposupe beighted Adde No. ei Novoz Cocros Linker to Exposure	3 TOTAL 50 245 246 E TOTAL 847E 1 90 310	LINKS 22. 11 88 227 228 LINKS 11, 12 80 198	5 -70 280 261 -5 -61 341	-76 172 345 -85 233	-67 234 470 -87 229	•				
N.Y.Z COORCI/ LIMEE TO EVPOSUPE BEIGHTED MODE NO. E N.Y.Z CCCRCI: LINKED TO	3 TOTAL \$47E 1 50 245 246 E TOTAL \$47E 1	LINKS 22. 11 68 227 228 LINKS 11. 12	5 -70 -70 -260 -261 -5 -6, 339	-76 172 345	•67 234 •70					
Novoz Coorci/ Linker to Evposupe beighted Node No. e Novoz Cocrci: Linker to Exposure Weighted	3 *074L \$47E 1: 90 245 246 E TOTAL \$47E 1: 90 310 622	LINKS 22 11 28 227 220 LINKS 11 12 80 196 398	-70 280 261 5 -61 341 342	-76 172 345 -85 233	-67 234 470 -87 229					
X++Z COORCI' LINEC TO E+POSUPE beighted  Node NC. ei X++Z CCCRCI: LINEC TO EXPOSURE MEIGHTED  NCDE NC8:	3 *OTAL \$4TE 1 90 2*5 2*6 E TOTAL \$4TE 1 90 310 622 5 *OTAL	LINKS 22. 11	5 -73 280 261 -8 -81 341 342	-76 172 345 -85 233	-67 234 470 -87 229					
NOTE NO 0: NOTE NO. 0: NOTE NO. 0: NOTE NO. 0: NOTE NO. 0: NOTE NO. 0: NOTE NO 0: NOTE NO 0: NOTE NO 0: NOTE NO 0:	3 TOTAL (ATE 1 50 245 246 E TOTAL (ATE 1 310 622 5 TOTAL (ATE 1	LINKS 22. 11 22. 227 228 LINKS 13. 12 80 196 398 LINKS	5 33C -73 285 261 5 6 339 -81 342 12 7 330	-76 172 345 -85 233 234	-67 234 470 -87 229 469				.00	.30
NOTO Z COORCII LINKEE TO EVPOSUPE BEIGHTEE  NODE NG. 81 X0Y0Z CCCRCII LINKEE TO EXPOSURE MEIGHTED  NCCE NC81 X0Y0Z COOROII LINKEE TO	3 TOTAL SATE 1 205 205 206 E TOTAL SATE 1 90 622 5 TOTAL NATE 1 91	LINKS 22 11 22 27 228 LINKS 15 12 398 LINKS 04 13	5 -73 280 261 -8 -81 341 342	-76 172 345 -85 233	-67 234 470 -87 229	78	-81	~87	-90	-78
X+Y-Z COORCI' LINKEC TO EYPOSUPE BEIGHTEC  NODE NC. ei X+Y-Z CCCRCI: LINKEC TO WEIGHTED  NCCE NCei X+T-Z COORDI' LINKEC TO LINKEC TO LINKEC TO	3 TOTAL VATE 1: 50 205 206 E TOTAL VATE 1: 90 622 5 TOTAL VATE 1: 91 93 97 97	LINKS 22. 11 22 227 228 LINKS 15. 12 8C 196 398 LINKS 004. 13 90 -75	5 -73 285 261 -5 -61 341 342 12 7, 330 6e	-76 172 345 -85 233 234	+67 234 470 -87 229 469	78		-	-	
NOTO Z COORCI' LINKED TO EVPOSUPE BEIGHTED  ADDE NG. E X.Y.Z CCCRCI! LINKED TO EXPOSURE MEIGHTED  MCGE NC 6! X.Y.Z COORDI! LINKED TO LINKED TO EXPOSURE	3 TOTAL (ATE 1: 50 245 246 E TOTAL (ATE 1: 510 622 5 TOTAL (ATE 1: 710 710 7115 )	LINKS 22. 11 28 227 228 LINKS 11. 12 8C 198 398 LINKS 04. 13 90 -75 254	5 33C -73 285 261 5 6 339 -81 342 12 7 330	-76 172 345 -85 233 234	-67 234 470 -87 229 469		-61 335	-67 251	-90 42	-78 194
NOTO Z COORCI LINKER TO EVPOSUPE BEIGHTED NODE NG. PINKED TO EXPOSURE BEIGHTED NGDE NG8! NOTO Z COORDI LINKER TO LINKER TO EXPOSURE EXPOSURE EXPOSURE EXPOSURE	3 TOTAL NATE 1: 50 245 246 E TOTAL NATE 1 91 622 5 TOTAL NATE 1 -70 115	LINKS 22. 11 28 227 228 LINKS 115. 12 80 196 398 LINKS 00. 13 90 -75 253	5 -70 -70 -70 -70 -70 -70 -70 -81 -81 -81 -81 -81 -81 -81 -81 -81 -81	-76 172 345 -85 233 234	-67 234 470 -67 229 469	78 151	335	251	42	194
X+Y-Z COORCI' LINKEC TO EYPOSUPE BEIGHTED  NODE NC. EI X-Y-Z CCCRCII LINKEC TO EXPOSURE MEIGHTED  NCDE NC8! X-Y-Z COORDII LINKEC TO LINKEC TO EXPOSURE EXPOSURE EXPOSURE EXPOSURE	3 TOTAL 14TE 1 50 245 246 E TOTAL 14TE 1 10 622 5 TOTAL 170 115 177 212	LINKS 22. 11 28 227 228 LINKS 15. 12 80 198 398 LINKS 04. 13 90 -75	5 -73 280 280 281 5 -81 341 342 12 7, 330 Ee	-76 172 345 -85 233 234	+67 234 470 -87 229 469	78		-	-	
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corresponding penalty associated with this pairing. The easting and northing values are the number of meters from the southwest corner of the area. This corner is the standard position for reference on a map. Knowing the southwest corner of the actual map area being analyzed, the nodes can be positioned on the map by finding the point X meters easting and Y meters northing from the southwest corner. Table 6.9 contains the neighborhood nodes for each node along the route. Three data items are provided: The nodes are listed on the third line, the unweighted exposure value pertaining to that node is listed on the fourth line, and the final weighted penalty for the node is given on the fifth line.

Figure 6.1 shows the position of the sensors and the resulting route for the first case. The route avoids the air defense sensors by traveling east before turning north. The destination point is approached from an easterly direction.

Figures 6.2 through 6.8 are the resulting routes for the cases listed in Table 6.3. In each Figure the location of the sensors are shown. The terrain in Figures 6.1 through 6.4 is flat to moderately hilly. There is a valley that proceeds from the southwest to the northeast through the center of this terrain. The rough terrain is located to the southeast and east. A large flat-top hill is located in the northwest.

The terrain in the second area is rougher (Case 5 through 8).

There is a prominent ridge running from the southeast to the center of the area. There are valleys on each side of this ridgeline that join in the northwest. In Figures 6.5 and 6.7, the route selection was difficult with the sensors located in the northern and central areas.

When the sensors were located on top of the ridge and to the south,

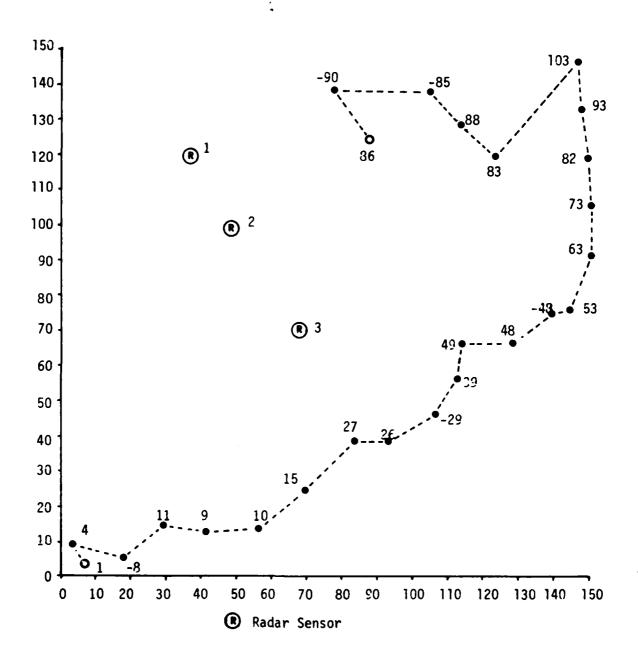


Figure 6.1. Case 1 - A1, R1, S1.

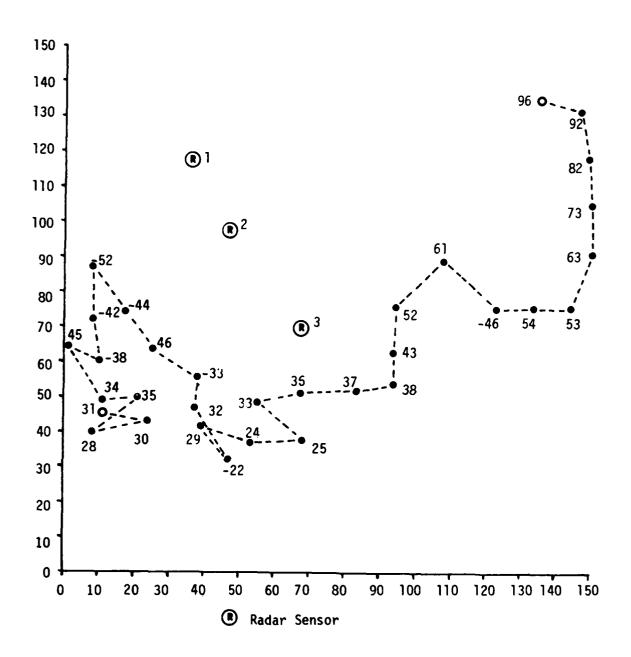


Figure 6.2. Case 2 - A1, R2, S1.

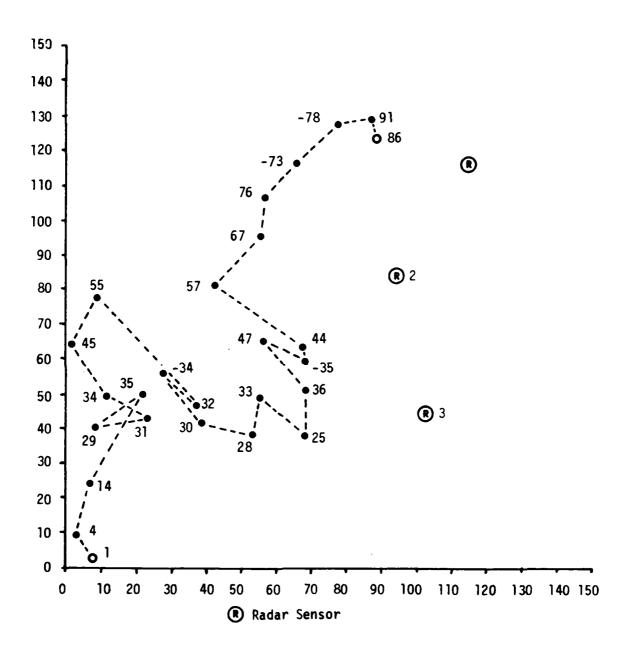


Figure 6.3. Case 3 - A1, R1, S2.

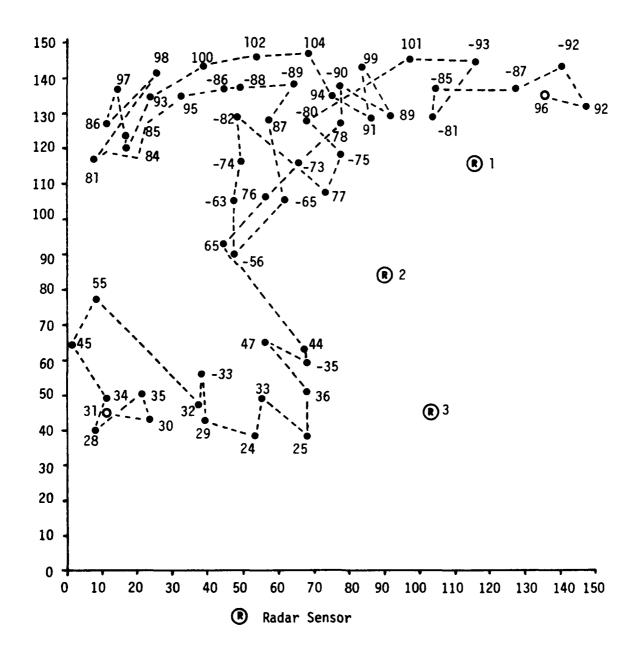


Figure 6.4. Case 4 - A1, R2, S2.

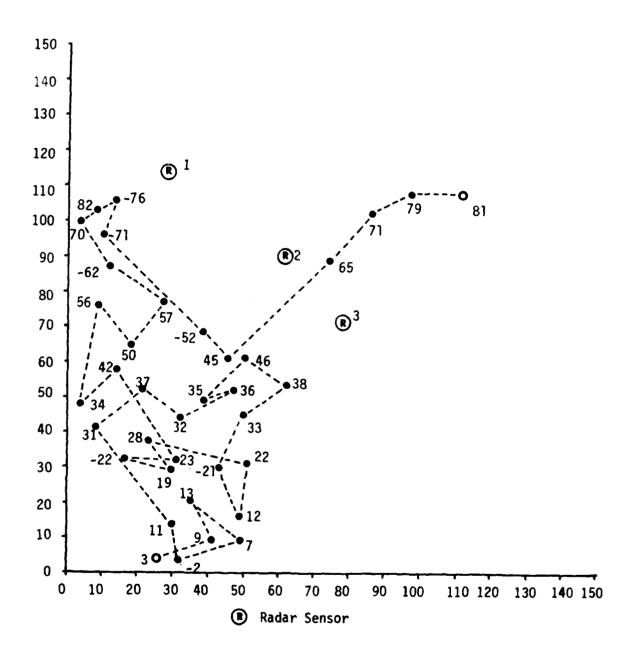


Figure 6.5. Case 5 - A2, R1, S1.

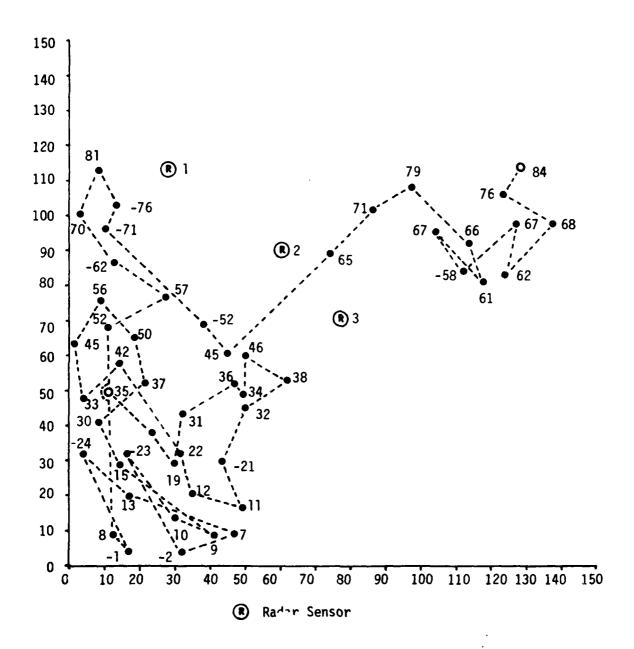


Figure 6.6. Case 6 - A2, R2, S1.

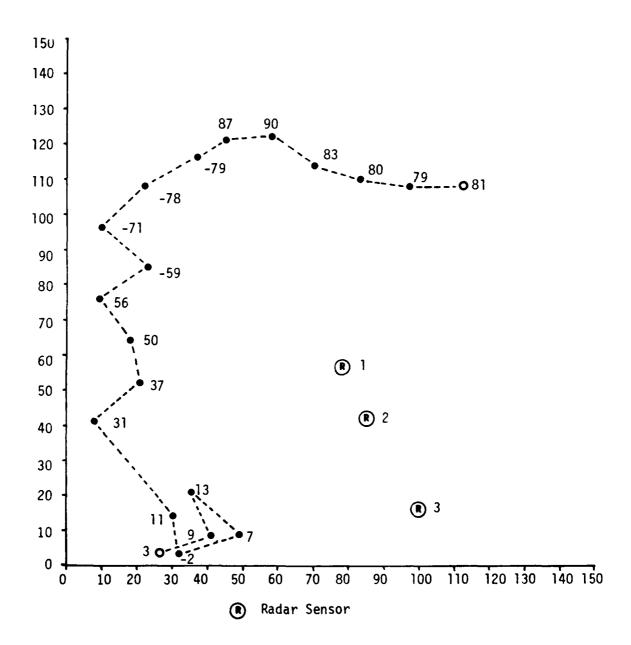


Figure 6.7. Case 7 - A2, R1, S2.

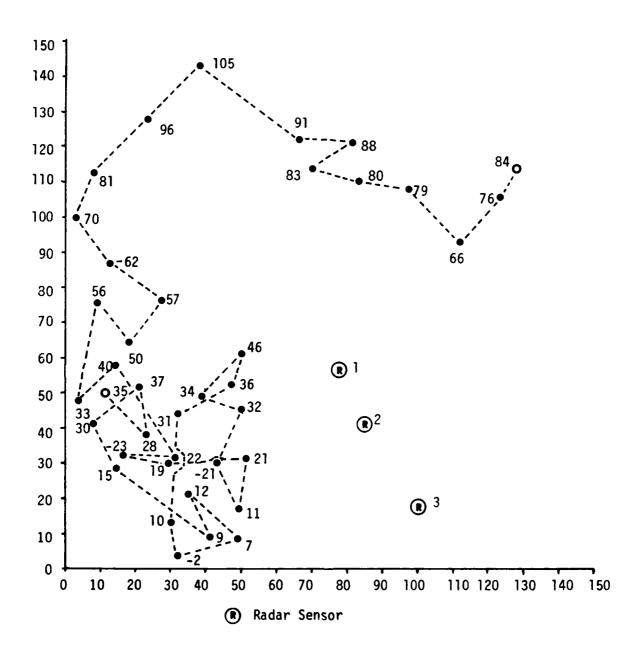


Figure 6.8. Case 8 - A2, R2, S2.

the routes selected follow the base of this ridge (Figures 6.6 and 6.8).
6.3. Refined Routes

These initial routes shown in Figures 6.1 through 6.8 were refined and the new routes are shown in those cases where improvement could be achieved. For case one, the refinement process accepted the initial results as final.

In the other cases improvement was achieved by the refinement process. The improvement in case two occurs at the beginning of the route (Figure 6.9). The route initially headed north and was not able to avoid the air defenses. The model reversed directions and utilized a southern route. The route refinement eliminates the first several nodes to achieve the improvement.

The radars are located in the east for cases three and four. The initial routes are to the north; however, the hilly region in the northwest caused the selection process to change directions and proceeds south. The refinement in case three smoothed the initial portion of the route (Figure 6.10). The destination point in case four is located beyond the line of radars; thus, causing the route selection to double back to avoid the air defenses. There is significant improvement when the route is refined (Figure 6.11).

In area two, the rougher terrain resulted in three of the four routes doubling back significantly. With the radars deployed on the high ground to cover the approach corridors, the route meanders considerably since the model searched for an acceptable low exposure route (Figures 6.5 and 6.6). The selection process finally reached node 45 from which the radars could be breached. Figures 6.12 and 6.13

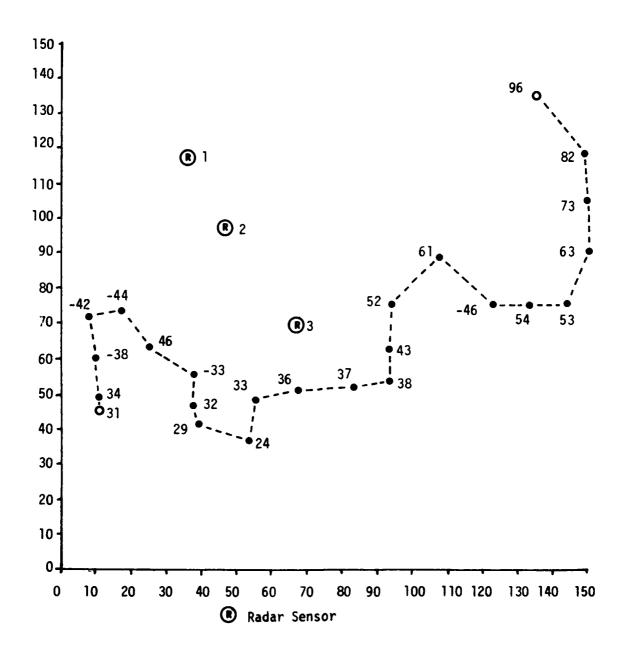


Figure 6.9. Case 2 - Refined Route.

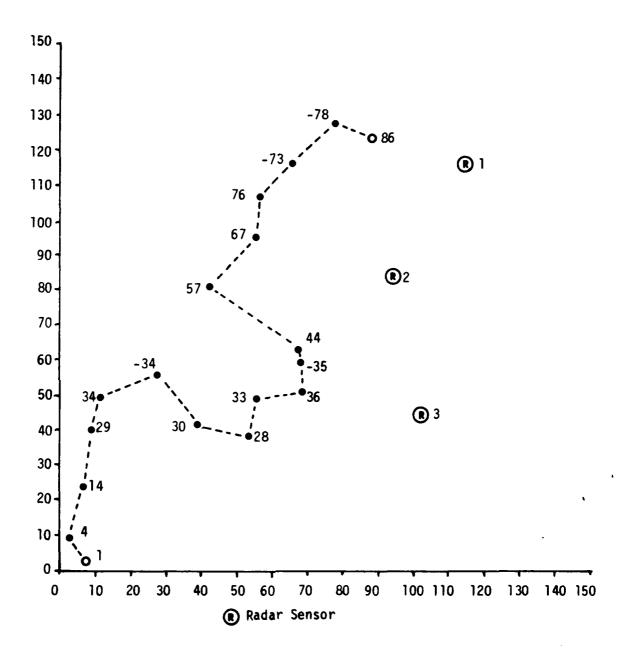


Figure 6.10. Case 3 - Refined Route.

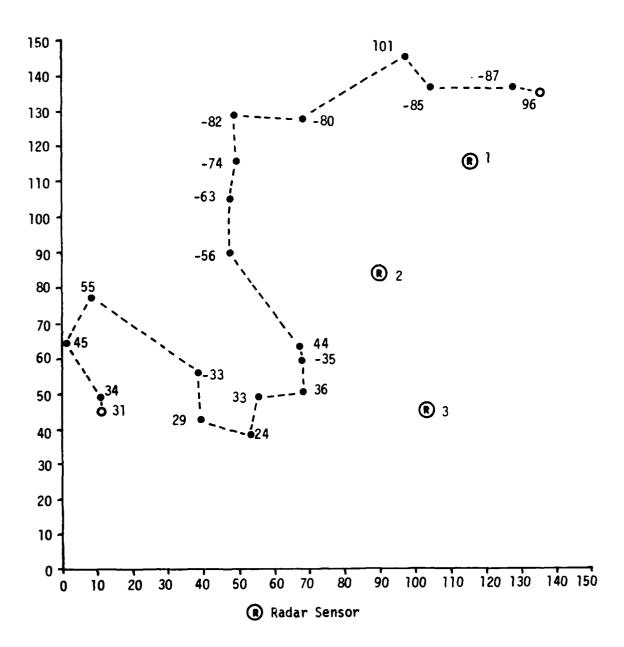


Figure 6.11. Case 4 - Refined Route.

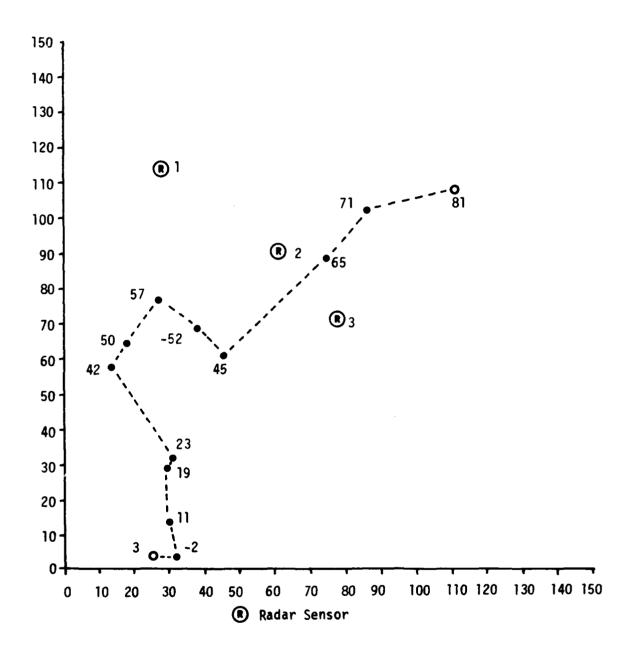


Figure 6.12. Case 5 - Refined Route.

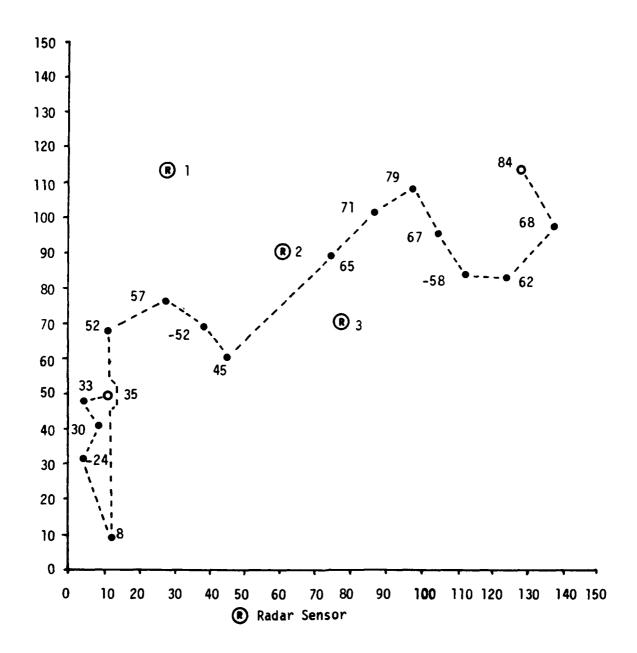


Figure 6.13. Case 6 - Refined Route.

shows considerable route improvement when these routes are refined. Figure 6.13 indicates that the route refinement is not perfect in that there is obvious improvement by proceeding directly from node 35 to node 52.

Case seven was the only route in area two that the initial route was acceptable. Only the first three nodes are eliminated in the refinement. For case eight, the initial node is located in a narrow valley forcing the route selection to proceed south. This direction is towards the air defenses causing the meandering in the route. The refinement caused the route selection to be across the valley entrance slope to achieve an acceptable route. The routes in Figures 6.14 and 6.15 are mostly along the base of the ridge. In Table 6.10 is a summary of the improvements in terms of nodes traversed.

Table 6.10 Route Improvement (Node Traversed)

Case	Initial	Final
1	25	25
2	32	24
3	26	18
4	57	20
5	37	13
6	51	17
7	20	16
8	39	15

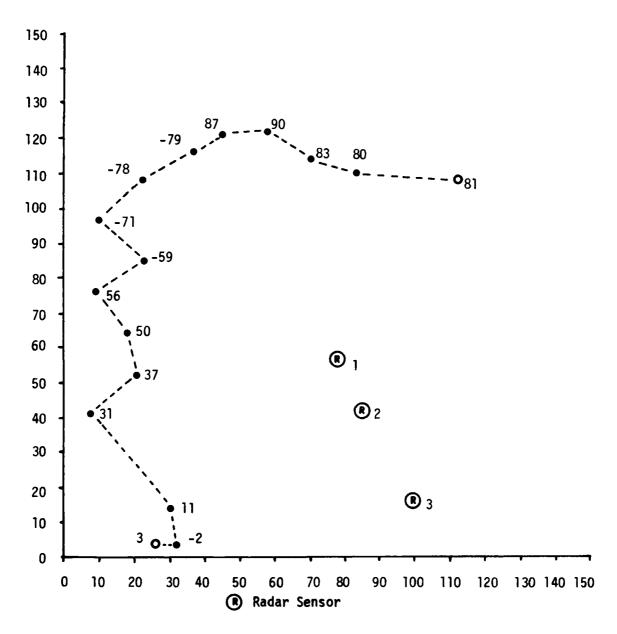


Figure 6.14. Case 7 - Refined Route.

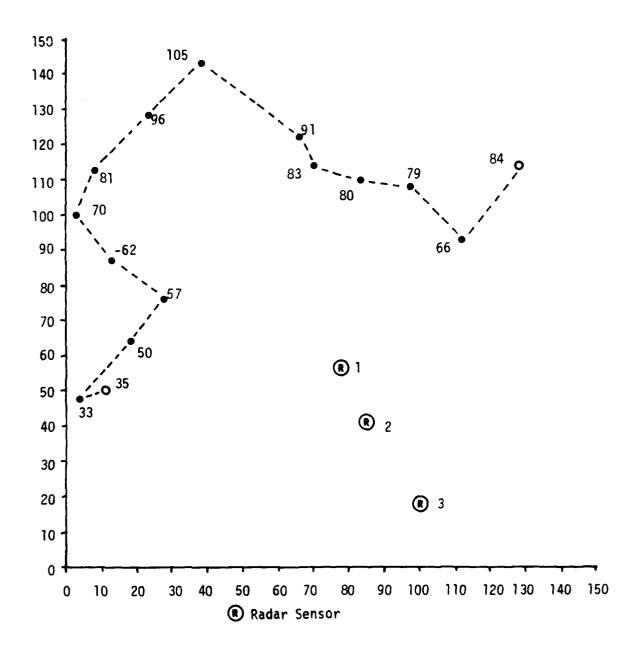


Figure 6.15. Case 8 - Refined Route.

# 6.4 Large Area Analysis

Several size terrain areas were utilized to evaluate the model's performance. The initial point was held constant and the destination and number of sensors were varied. Table 6.11 gives the location of the sensors and the size area where they were utilized. The areas ranged from 20 by 20 km to 35 by 35 km. The elevation varied from 270 to 610 meters for the 20 by 20 km case and varied from 270 to 850 meters for the 35 by 35 km cases. The limiting factor in the area size is computer core capacity.

The southwest corner of each area is the same. The larger size areas are obtained by increasing the x and y distance from this corner. The test area discussed in section 6.2 is the southwest 10 x 10 km sector of these larger areas. As one travels from the southwest to the northeast the terrain becomes progressively rougher. Thus, the routes were selected to travel this same direction. They begin in the southwest and end in the northeast sector. Since the areas are larger the lethal radius of the systems were increased to 6 km.

The large size of these areas resulted in voluminous output from the model. Therefore, the results are summarized rather than presented in detail as the small areas. The routes developed by the model had the same characteristics of the small areas. The route end points and the sensor deployment determined the smoothness of the route. The routes for all cases would begin fairly straight; however, the deployment of the sensors and terrain roughness would cause meandering of the route when it reached the central area of the 35 by 35 km case. The refinement process eliminated the doubling back as it had done in the small cases.

Table 6.11 Sensor Deployment

20-20 km	Area	35-35 km	Area
Sensor	(X,Y,Z)	Sensor	(X,Y,Z)
1	(97, 280, 500)	1	(300, 414, 490)
2	(165, 250, 440)	2	(371, 214, 490)
3	(193, 71, 400)	3	(14, 314, 450)
25-25 km	Area	4	(285, 328, 460)
Sensor	(x, y, z)	5	(228, 407, 520)
1	(97, 280, 500)	6	(285, 243, 450)
2	(165, 250, 440)	7	(200, 214, 410)
3	(193, 71, 400)	8	(336, 71, 350)
30-30 km	Area	9	(364, 288, 530)
Sensor	(X,Y,Z)	10	(97, 280, 500)
1	(97, 280, 500)		
2	(336, 71, 350)		
3	(364, 288, 530)		

Table 6.12 provides an overall summary of the six large cases.

The computer processing time for each of the cases indicates that terrain size significantly increases the run times for the model. The 30 by 30 km case, when compared to the 35 by 35 km case of three radars, indicates the deployment and route end points can produce very different results. The initial routes for these two cases are refined to approximately the same size. In all cases the refinement provided an improvement in route performance by reducing the penalty.

ARMY MISSILE COMMAND REDSTONE ARSENAL AL PLANS ANAL--ETC F/6 15/3 A HEURISTIC ROUTE SELECTION MODEL FOR LOW LEVEL AIRCRAFT FLIGHT--ETC(U) AD-A091 793 MAY 80 M J DORSETT DRSMI/D=80=5-TR UNCLASSIFIED SATE-AD-FOSO DAO

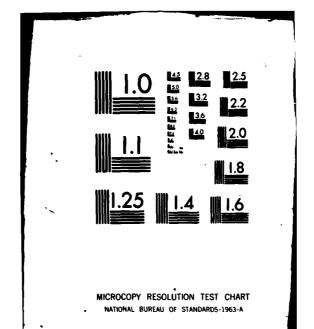


Table 6.12 Large Area Cases

Area	Sensors	Low Nodes	High Nodes	Route Nodes	Penalty	Refined Nodes	Penalty	Run Time (sec)
20-20	ო	415	389	63	9669	28	3510	79.5
25-25	ო	648	624	218	17498	35	2086	114.1
30-30	ო	938	918	458	44499	63	7793	155.1
35-35	ო	1289	1258	181	12783	99	5325	187.6
35-35	ဟ	1289	1258	331	29082	98	7007	216.9
35-35	01	1289	1258	466	95154	26	19942	284.3

#### CHAPTER VII

### MODEL VALIDATION

#### 7.1 Introduction

For the model to be of any utility, it must be tested and validated. A comparison is required between a tactician's route analysis and the heuristic model which attempts to approximate that analysis.

The test area has relatively flat terrain through the center region and high ground on the eastern edge and in the northwest corner. The hilly areas are difficult for the model logic to process into a smooth route line that an individual would expect to see for a route.

A tactician planning a route needs to visually perceive the relationship between the route initialization, positions to be avoided, and the final destination. The air defense sensors will be bypassed, if possible, by traveling around these positions outside their effective engagement limits. However, one tactician's ideal route may be another tactician's worst case. The manually produced route is a highly subjective analysis.

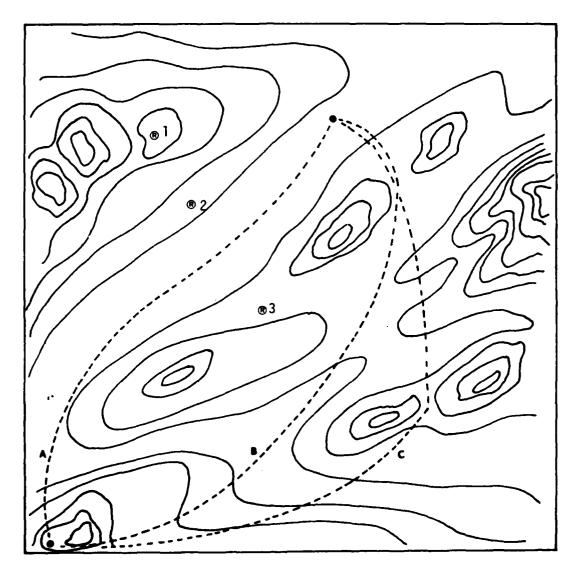
# 7.2 Manual Route Selection

The development of a route by manual analysis requires studying a topographic map of the appropriate area. The development of a low flying aircraft route dictates the type of information desired: The

location of the air defenses, the valleys, the hill tops, and the built-up areas is important. The information concerning the area is utilized in the route selection to avoid the air defenses and enemy concentrations.

The problem with reading a topographic map is trying to perceive the 3-dimension aspects of the terrain. Ordinarily, relief is shown by contour lines. For level terrain the contour lines are widely spaced whereas rough or hilly terrain will have densely packed contour lines. The rivers and streams give the location of valley floors and lowest points in flat terrain. One method for showing the vertical aspects of the terrain is to draw a profile of the elevation. Along a line between any two points the contour elevations are plotted, from which LOS can be determined and the degree of terrain roughness (see Figure 2.2). For a large area and even a modest number of points this approach is impractical.

Figure 7.1 depicts the terrain area used in the test case and indicates the relative position of the hills and valleys with the sensors. The routes shown in Figure 7.1 were developed by questioning analysts whose expertise is in air defense routing. Providing them with the location of the sensors and the route end points on a topographic map, the routes A, B, and C were chosen. If a direct route is required, route A is proposed since it follows the valley floor and passes midway between two of the sensors. If the sensors are to be avoided, routes B and C are chosen since they utilize the hills as masks and bypass



Radar Sensor
A,B,C Routes

Figure 7.1. Terrain Area One.

the sensors. Routes B and C are preferred by all the analysts. The question of model validity is whether or not similar routes are produced when the model uses its decision logic.

#### 7.3 Model Route Selection

For development and testing of the model a 10 by 10 km area was selected from the 35 by 35 km data base that is representative of both relatively flat and hilly terrain. In the initial testing, the model would form a circuit through several nodes before returning to the starting node. After these first runs, decision logic was added in the form of weighting as described in Chapter IV. The major piece of information the model considers that the tactician has difficulty in assimilating is the LOS determination. The degree of visibility a node has with the sensors provides a basis upon which a quantitative selection can be made.

To test this hypothesis, the model was run with different levels of information available to the decision logic. With only the distance and height of neighboring nodes, the model produced a very irregular route. The model would exhaust the nodes in the neighborhood before leaving that immediate region for any new points (Figure 7.2).

With the exposure value of a node added to the decision logic, this second level of information allowed the model to produce a node of linkage which resembled a route (Figure 7.3). The third level provided data on radar location and range with which the model was able to produce a route that approximates the route an individual analyst would

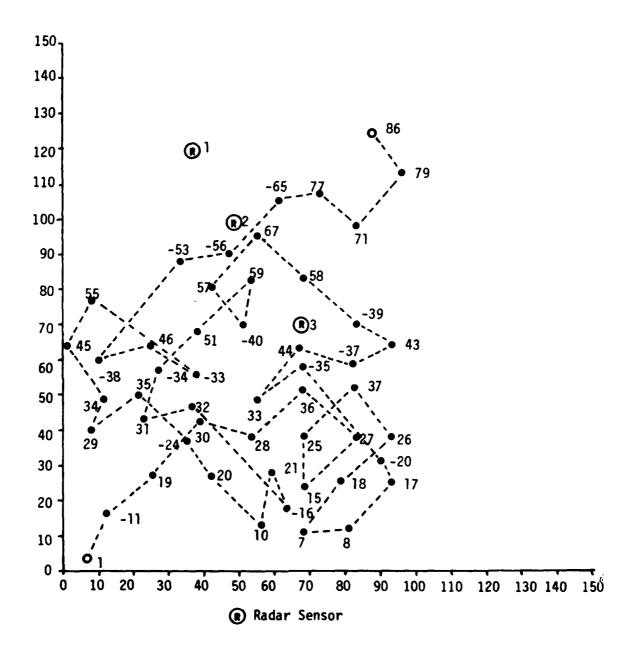


Figure 7.2. Minimal Information Route.

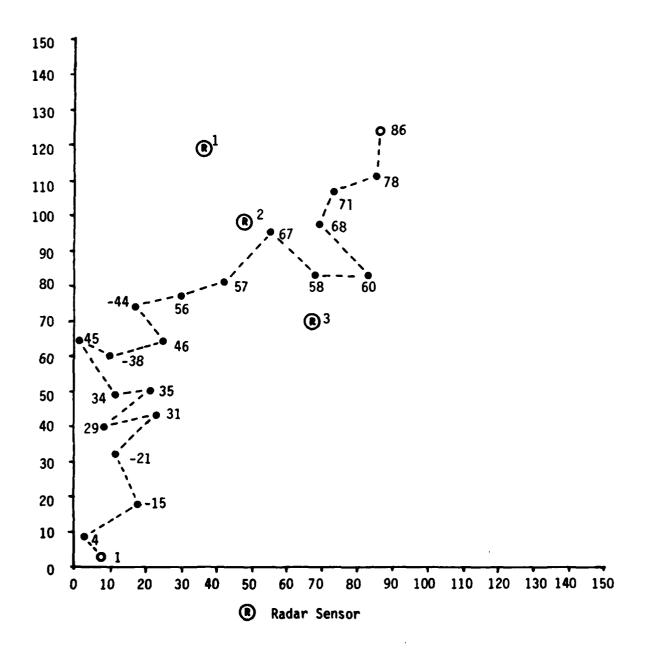


Figure 7.3. Exposure Value Route.

select (Figure 7.4). In Figure 7.4 the radars are deployed in the northern sector and the route avoids them by a southerly route.

When the destination is within 1 km of the current position the final terminal weighting forces the choice of the next position to be the destination or an intermediate node. Normal attacking procedures have some distance from target at which the attack is committed and one proceeds directly towards the target. With high speed aircraft (250 m/sec) this attack point is 3 to 6 km away depending on the type of ordnance being used. Stand-off munitions exist that allow the attacking aircraft to be 20 or more km away when releasing their ordnance, if the target is heavily defended.

The results of the model are a series of linked points which comprise a route. A comparison of Figure 7.4 with Figure 7.1 indicates that the preferred route C is approached with the radar avoidance weighting. The degree of match between the model route and the manual route give a visual indication of acceptability.

### 7.4 Model Evaluation

The exposure value of each route node point was used as a basis of comparison. Since the routes are not of equal length, the exposure of the node links were used to establish the exposure value of a route. The calculation of route exposure is given below:

EVR = 
$$\sum_{j=1}^{n-1} EV(N_{j+1}) \left[ \frac{d_{j+1}}{D} \right]$$

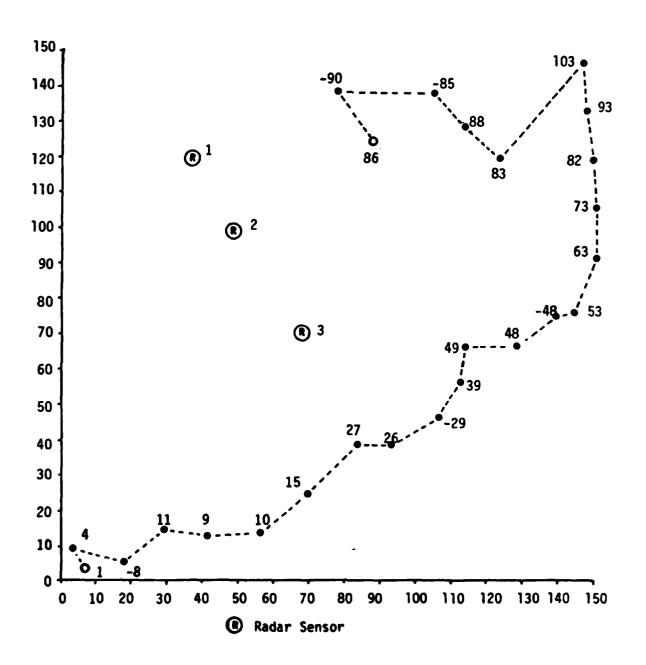


Figure 7.4. Complete Information Route.

where 
$$D = \sum_{i=1}^{n-1} d_{i+1}$$
,

D =The total length of the route,

 $EV(N_{i+1})$  = The exposure value of route node i+1,

d<sub>i+1</sub> = The distance from node i to node i+1,

EVR = The exposure value of the route.

Utilizing this relation the model routes can be compared with the manually chosen routes. The scenario for the manual selection and the model is Case 1. In Table 7.1 the route exposure values are given for the three manual routes and the model route. The preferred route C and the model route achieved an exposure value of 0.844 and 0.888 respectively.

The other routes that were developed by the model indicate that the deployment of the sensors within the terrain have a definite effect on the selection process. Rough terrain with sensors deployed to cover the low elevation corridors is the most difficult case for the model to evaluate and select a minimum exposure, minimum elevation route for penetrating the air defenses.

Table 7.1 Route Exposure Values

Route	EVR
A	1.582
В	1.325
С	0.844
Model	0.888

### CHAPTER VIII

### CONCLUSIONS AND RECOMMENDATIONS

#### 8.1 Conclusions

This research has addressed an area of air defense modeling which is normally analyzed visually with topographic maps and coverage diagrams before any tactical gaming is performed. A significant problem in analyzing terrain from a topographic map is perceiving the 3-dimensional aspects of terrain features. The degree of visibility a manually developed route will have can only, at best, be estimated. Any route selected is based on the particular individual's ability to be a good tactician. Using the subjective route for air defense modeling adds an unknown to the war gaming results.

The model that has been presented overcomes the shortcomings cited above and provides a minimum-exposure, minimum-elevation route. The developed route then serves as a baseline from which other flight paths can be evaluated. The model provides the visibility or exposure of all the high and low elevation nodes within the area. These values can be used as a reference for evaluating the visibility of specific areas of the terrain in addition to route identification.

Terrain roughness has a marked effect in the developed route.

By placing the radar sensors at key positions to cover approach corridors, the model develops long routes in searching for a minimum exposure route. The long routes indicate the problem of traversing an area undetected by modern air defenses. The addition of more sensors

increases the penalty associated with travel through an area and also increases the route length. In the 35 by 35 km case the penalty value increased from 12783 for the three radar case to 95154 for the ten radar case. The route nodes also varied from 181 to 466 in the initial routes.

### 8.2 Recommendations for Further Research

In testing this model it became very obvious that minor changes in weighting of a single node point would result in an entirely different route. Further research is needed into the sensitivity of the weighting scheme utilized in this model.

The decision logic that is used in this model is by no means the only one that should be used. There needs to be the ability to enter check points through which the route must pass on its way to the destination. Along this same line of reasoning, the model could be modified to evaluate a proposed route rather than find the route.

The idea of limiting the next node selection to a neighborhood about the current position could be expanded to other problems besides air defense aircraft routes. The routing of oil and gas pipelines could be analyzed using the model. The radar sites could be a town or built up areas to be avoided. The weighting of the height penalty could be increased to favor level terrain.

Lastly, the author hopes that this research might serve as a start for further effort into the general problem of routing.

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**APPENDICES** 

## APPENDIX A

## ROUTING PROBLEMS

Within this appendix are the data tables for the additional problem cases discussed in Chapter 6. Each set of tables is preceded by a page identifying the case. The tables for exposure values in these cases were not included for the sake of brevity.

Case 2 - Area 1, Route 2, Sensor set 1.

Table A.1. Case 2 - Node Linkage for Route

				-		
FROM	EASTING	NCRTHING	TO	PENALTY	EASTING	NORTHING
31	770	10150	30	26	1610	10010
30	1610	10010	28	74	560	9800
28	560	9800	35	2	1470	10500
35	1470	10500	34	164	770	10430
34	770	10430	45	1	70	11480
45	70	11480	-36	154	700	11200
-38	700	11200	-42	260	560	12040
-42	560	12040	-52	231	560	13090
-52	560	13090	-44	97	1190	12180
-44	1190	12160	46	188	1750	11480
46	1750	11460	-33	214	266 <b>0</b>	10920
-33	2660	16520	32	354	2590	10290
32	259C	10290	-22	452	3290	9240
-22	3250	9240	29	145	2730	5940
29	2730	9940	24	232	3710	566C
24	3710	5660	25	243	4760	9660
25	4760	9660	33	228	3650	10430
33	3850	10430	36	295	4760	10570
36	4760	10570	37	240	5818	10640
37	5810	10640	38	198	6518	10766
38	6510	10780	43	298	6580	11410
43	6580	11410	52	278	6588	12320
52	6580	. 12320	61	255	7560	13230
61	756G	13230	-46	252	8540	12250
-46	8540	12250	54	87	9380	12320
54	9360	12326	53	56	10050	12320
53	10080	12320	63	71	16500	13370
63	10500	13370	73	27	10500	14350
73	10500	14350	6.2	<b>4.7</b>	10430	15330
82	10430	15330	92	96	16290	16248
92	10290	16240	96	285	9450	16450

Table A.2.	Case 2 - Node	Linkage		
NODE NO. 31 TO	TAL LINKS 7			
X.Y.Z COORDINATE	11. 45. 260			
LINKED TO 3	4 28 35	30 -21	-52 -26	
	U 33 34	30 -21 25 161 26 324	241 160	
WEIGHTED 10	1 168 70	26 324	242 161	
NODE NO. 30 TO	TAL LINKS 9			
Y-Y-7 CODEDINATE	23. 43. 200			
LINKEC TO 3	5 14 12	28 -23	-24 -34	-21 -33
EXPOSURE 10	5 34 32 0 51 118	28 -23 36 356	280 343	186 306
WEIGHTED 10		74 714	281 688	374 618
NODE NO. 28 TO	TAL LINKS 4			
X+Y+Z COORDINATE	8. 40. 280			
LINKED TO 3	4 35 -21	-23		
EXPOSURE P	P C 258	295		
LINKEC TO 3: EXPOSURE P WEIGHTED 17	e 2 516	296		
	TAL LINKS 6			
Y-Y-Z COCACINATE	21. 50. 240		_	
LINKED TO 3	4 46 -34	-30 -23	-24	
LINKED TO 3 EXPOSURE 9	1 258 373		213	
EXPOSURE 9 WEIGHTED 18	1 258 372 4 518 742	408 55C	214	
			•••	
NODE NO. 34 TO	TAL LINKS 3			
X+Y+Z CCOPDINATE	11. 49. 280			
LINKEC TO 4	5 -38 -23			
EXPOSURE	11. 49. 280 5 -38 -23 3 254 186 1 255 181			
MEIGHTED	1 255 181			
NOCE NO. 45 TO	74 74.00 1			
X-V-7 COMPTIMATE	TAL LIAKS 3			
ITAKED TO 5	1. 64. 30C 5 -36 -42			
EXPOSURE 22	5 -3ê -42 9 163 211			
WEIGHTEC 45				
NODE NO18 TO	TAL LINKS 3			
MATAZ CCCALINATE	10. 50. 310			
LINKED TO 4	1 259 165			
EXPOSURE 15 WEIGHTED 30	• 260 332			
NODE NO42 TO	TAL LINKS 3			
X.Y.Z COORDINATE	9			
LINKED TO 5	5 -44 -52			
CALOSCES :				
WEIGHTED 28	0 254 231			
NODE NO52 TO	TA:   Tawe &			
MAYAR CCORDINATE	TAL LINKS 5			
LINKET TO 5	5 70 -EA	-44 -59		
EXPOSUPE 27	G 313 339	56 246		
MEIGHTED 54	8. 57. 350 5 70 -54 0 313 339 2 314 660	97 494		
NODE NO44 TO	TAL LINKS 5			
X.Y.Z CCOPDINATE	17. 74. 330	_	•	*
LINKET TO 5	17. 74. 330 5 46 56 5 187 208	-43 -54		
LINKET TO 5: EXPOSURE 30 WEIGHTED 62	5 167 208 C 166 416	251 242		
MEIGHTED 63	C 166 416	504 486		
NCDE NO. 46 TO	TAL LINKS 5			
N.Y.Z COCFGINATE	25. 64. 300			
LINKED TO 5	1 56 -34	-43 -33		
EXPOSURE 25	B 566 306	360 213		
BEIGHTED 50	2 524 614	722 214		
NODE NO33 TO	TAL LINKS 4			
ANTRE TA	250 200 300	-36 -34	-40	
EXPOSION 12	4 31 27 4 306 177	-35 -34 •0• 381	335	
MEIGHTED 18		*0* 381 810 764	335	

Table A.2.	(co	nt'd.	)						
NODE NO. 32	70734	. The C	. 5						
X.V.Z COORDIN	ATE S	37. 4	7. 280						
LINKED TO EXPOSURE WEIGHTED	2 <b>9</b> 227	-24	-34 332	-36	-22 225				
RE ICHIED	456	584	666	332 666	452				
NASS NA									
NOOE NO22 N.Y.Z CCCRCIN	16146	11NNS	2. 290						
N.Y.Z CCCRCIN LINKED TO EXPOSURE	1.0	24	50	29 144	-24 243	-14			
EXPCSURE WEIGHTED	315	268 538	190	144	445	247 456			
				• • •		- 70			
NOCE 40. 29	TOTAL	LIAKS	2. 380						
LINKEC TO	24	``:e	15	-24	-34				
X.V.Z COOPCIN LINKEC TO EXPOSURE WEIGHTED	231	2.2	252	329	310				
at I CH I E D	752	200	708	660	311		•		
NODE NC. 24	TOTAL	LINKS	6						
NODE NC. 24 N.Y.Z COOPDIN LINKED TO EXPOSURE WEIGHTER	ATE !	:3. :	F. 285	1.6	16	-14			
EXFOSURE	7.2	2 - 5	242	307	36 219 2100	+16			
ME ICH TEL	<b>◆</b> F .	5:2	245	616	2100	1234			
NODE NO. 25	TOT:L	LIAKS	P						
N.Y.Z COCREIN	ATE (	18. 3	8. 280						
LINKEC TO	36	20	13	27	17	33 227	37 275	-24 369	
X+Y+Z CCCRCIN LINKEC TO EXPOSURE WEIGHTED	3126	5-0	518	271	17 245 500	558	276	740	
X.Y.Z COOPEIN	TCT2L		9. 200						
LINKED TO	36	4.4	-36	- 35					
LINKEC TO EXPOSURE NEIGHTED	254 265	278	418 419	303					
NOCE RO. 36	70741		4.7	3040					
X.V.Z COSECIN	A 35 (		1. 280						
LINKET TO	44	37	47	27	-35	-37			
EXPOSURE JEIGHTED	197	219	47 337 3380	1 76 354	414 4150	332			
				334	****	304			
NODE NC. 37	TOTAL	LINAS	7						
X.Y.Z COORCIA LINKED TO EXPOSURE	A 16 1	42	21	43	2€	-37	-35		
	197	363	238		166	400	320		
MEIGHTED	196	364	418	305	334	<b>4610</b>	3210		
NCDE NC. 36	TOTAL	LINKS	5						
N.Y.Z CCCPCIN LINKED TO EXPOSURE	ATE 4	53• 5	4. 28C						
EXPOSURE	297	250	258	-29 245	-28 258				
WEIGHTED	298	2510	2550	492	516				
NODE NO. 43	TOTAL		•						
X.Y.Z COC=CIN	ATE .	14. 6	3. Z90				•		
LIAKED TO	42	52	-37	-39	-47				
X.Y.Z COCTON LINKED TO EXPOSURE WEIGHTED	311	278	262 526	290 2910	28 <b>6</b> 287				
					- =				
NCCE NC. 52	TOTAL	LINKS	6. 300						
LINKED TO	60	62	42	61	-45	-47	-50	-35	
X.Y.Z CCCRDIN LINKED TO EXPOSURE WEIGHTED	291	277	231	264	354 710	335 336	342 343	288	
					/10	336	343	2690	
NOGE NO. 61 X47+2 COCRCIN L14#ED TO E4POSURE WE1GMTED	TOTAL	LIAKS	9						
XOTOZ COCRCIN	ATE 11	72	9, 336	-50	-60	-62	-47	-45	-46
ENPOSURE	339	227	346	341	-60 315 316	313	255 572	287	125
AEICHLED	340	456	694	684	216	314	572	576	252

# Table A.2.(cont'd.)

NOCE NO	A4 TOTAL	1 1445					
X.Y.Z CCCRD	INATE 1	22. 7	5. 3110				
LINKET TO	A 8			-45			
LINKED TO EXPOSURE	144		77		1	-55	
WEIGHTED	176		234			237	
ACIGNIED	294	• 1	479	665	329	238	
NODE NO.	54 TOTAL	LINKS	6			•	
X+Y+Z CODAD	INATE 1	34. 7	6. 310	Į.			
LINKED TO	53	4.8	50	- 4 A	-55	-57	
EXPCSURE	55	103	90	110		224	
MEIGHTED	56	208	182	222	235		
NCRE NC.	53 TOTAL	LIKKS	5				
X+Y+Z COORD							
	50				-55		
CABUSTRE	* 7 6	70	111	2 4 £			
WE IGHTED	258	71	222	247	216		
NOTE NO.	63 TOTAL	LIAKS	5				
X+Y+Z CCORD	INATE 1	=5. =	1. 340				
LINKED TO	73	-67		-55	-5A		
EXPOSURE	26	150	261	-33	- 28		
MEIGHTED	27	600	284	144	235 472		
	_	***	• • •	32-	4.2		
NCCE NO.	73 TOTAL	LINKS	7				
X+Y+Z COORC							
LINKED TO	82	-69	-61	-67	-58	-57	-55
EXPOSUPE	56	322	312	266	270	241	187
EXPOSUPE WEIGHTED	57	323	626	534	542	484	
NCDE NC.	es TOTAL	LINKS	•				
X.Y.Z CCCAD:	INATE 1	49. 11	9. 340				
	92	-77	-65	-74	-67		
EXFOSURE	95	204	288	161			
WEIGHTED		205					
NODE 40. 9	2 70741		•				
X.Y.Z CGOFCI	NATE 1	47. 33					
LINKED TO	96	163	-77	-97	-76		
EXPOSURE	284	41	44.5	-72	155		
BEIGHTED	285	14463					
	567	15200	126	1-16:	46800		

Case 3 - Area 1, Route 1, Sensor Set 2.

	QD:4	•				
FROM	E45715.	<b>6.7 6</b> 7 6 7 7			•	•: • · · · ·
1	••:	• ;			•••	*
-11	647	•		•	•	***:
19	1796	• • •		• •	*4	***:
30	2730		•	•	4.1	****
2.6	3 71 7	•••	•			.;• • •
36	4766			•	* 1 3 3	
27	5010	1001	•	٩.		100
26	6516	9661	į •	110	3134	0020
10	3536	. 0024	4.5	• (	• 7 • 6	74.6 (
25	4748	9601	3.3	1.	1038	10-30
13	3050	16416	. • •	16,	• '68	11136
- 35	4766	11130	• 1	167	1450	11250
47	392(	11556	• •	111	• • • •	11-10
44	4698	11016	43		.500	11-16
43	6580	11416	-47	99	7200	12250
-47	728C	155.6	52	61	.560	12:26
5.2	9829	12370	€ 0	1.7	9818	12610
€ 0	5810	1301C	-•1	176	4.01	11970
-41	4760	11973	- 3 7	186	5740	16768
-37	5746	11130	50	2	6510 5888	11-10
36	6513	. 10700	42	162	7910	11620
42	5880	11410	49	62	3966	11650
49	7910	11620	• 6	32 50	16616	11760
48	2966	11620	50	99	7388	12320
50	10010	11760	54	70	4540	12250
54	9380	12320	-46	172	5450	13200
-46	8540	12250	-55 53	***	10020	12320
-55	9450	15560		62	10500	13370
53	10080	12320	63 73	27	10500	14350
63	10500	13376	92	36	10430	15330
73	10500	14350	93	65	10290	16240
82	10430	15330		64	10220	17226
93	10290	16240 17220	103 -52	177	5800	17010
103	10556	-	-93	186	6050	17060
-92	9860	17010 17080	-85	254	7280	16590
-95	8050	<del>-</del>	92	157	6370	16030
-85	7280	16550 16030	86	282	6090	15689
92	6370	100.00	9.0			

Table A.4.	C	ase 3	- Node	Lin	kage				
		LLINKS	270						
N.Y.Z CCORCIN		7.	. 27C	-11					
LINKED TO		-6	-	67					
EXPOSURE	85	223	173						
WEIGHTED	9.6	224	174	68					
NOCE NC11			6						
X.Y.Z COORDIN					_	_			
LINKED TO		4	19	-15	-6	-6			
EXPOSURE	95	52	• 0	174	170	171			
WE 1G#TED	76	136	<b>41</b>	175	342	344			
NCDE NO. 19	TOTA	L LINKS	7						
N.Y.Z CCOREIN	4 TE	25. 2	7. 30C						
LINKED TC	11	30	-23	-15	-13	123	-21		
EXPCSUPE	154	53	180	221	173	123	103		
METCHLED	310	54	181	***	346	124	20 P		
NODE NO. 30	TOTA	L L!NKS	7						
X.Y.Z CCORDIA	A T F	35. 4.	282						
A THE COMMIN		28	20	-24	-22	-33	-34		
LINKEC TO EXPCSURE	154	91	123	189	146	150	179		
WE IGHTED	155		248	380	294	151	180		
RETOLIED	133	72	240	366	674		100		
NODE NO. 28									
X.Y.Z CCORCIN	ATE	53. 3	280						
LINED TO	33	21	25	20	36	-22			
EXPCSURE	143	126	105	176	70	243			
	141		106	354	71	4 6 8			
_									
NODE NC. 36	TOTA	LLINKS	8						
X.Y.Z CCORCIN		Eë, S				_			
LINKED TO		25	. 33	37	47	27	-35	-37	
EXPCSURE	235	120	i 20	115	172	£5	265	201	
WEIGHTEC	233	242	242	116	346	132	26€	505	
NODE NC. 37	TOTA	LLINKS	e						
N.Y.Z CCCRCIA	378								
LINKED TO		42	27	43	5.6	25	-37	-35	
EXFCSURE	76	242	114	127	2~	6ê	269	194	
MEIGHTED	77	466	233	128	<b>5</b> C	126	270	195	
			,						
NCCE NO. 26	TOTAL	LLINKS							
M.Y.Z COCREIN		93. 3	200						
LINKED TO		17		-20	-28	-29	-18		
EXPOSURE	143	128	57	181	210	115	155		
WEIGHTED	144	258	116	364	211	116	246		
NCDE NC. 16	7074	LLINKS	9						
			•						
X.Y.Z CCORDINA						_			
LINKED TO			17	e	25	. 7	-20	-12	-16
ENPOSURE	154		160	150	9.0	54	187	192	115
WEIGHTED	310	137	161	365	71	190	186	386	234
NCCE NO. 25	TOTAL		5						
N.V.Z CCORDINA									
TAMES TO		***	3	33	-12				
LINKED TO EXPOSURE	154	15 148	27 195	126	474				
WEIGHTED	310	256	150	127	950				
62105150	-10	476	130	121	750				
NODE NO. 33	TOTAL	LLINKS	3						
X.Y.Z CCOPEIN	STA	55. 4	9. 28C						
LINKED TO	44	- 36	-34						
EXPOSURE	75	255	106						
WEIGHTEC	:52	256	107						
MARK 44									
NODE NO35	TOTAL	LINKS	· · · · · · · · · · · · · · · · · · ·						
MATAZ COOPDINA	FTE	te. 5	9. 250						
N.Y.Z COOPDING	44	47	-41	-37	- 35				
EXPUSURE	1,2	106	215	110	176				
MEIGHTEC	176	107	216	111	144				

Table A.4.	( co	nt'd.)								
NCCE NO. 47 N.Y.Z CCCRDIN: LINNED TO	TOTAL STE	LINKS 56. 65	• 290 -36	-+1						
ENPOSURE	110	260	209	170						
WEIGHTED	iii	261	420	342						
	TCTAL ATE	LIAKS 67. 63	21 250							
LINKEE TO	42	58	59	60	43	38	51	27	52	57
LINKED TO	32	62	65	-41	-37	-40	-35	-36	-49	-33
LINKES TO	-56									
EXPOSURE	183	207	237	197	68	34	195	93	90 220	202 149
EXPOSURE	67 233	168	216	243	185	202	215	150	220	
EXPOSURE WEIGHTED	184	209	2386	396	65	70	392	188	910	203
WE IGHTED	136		2176	244	186	203	2190	382	442	300
	2340									
NCCE NO. 43		LINKS 94. 63	6 290							
LIAKED TO	36	42	52	-37	-39	-47	•			
EXPOSURE	100	186	7 9	143	163	58				
WEIGHTED	202	187	600	588	164	59				
NCDE NO47			e • 330							
LINKES TO	52	45	61	€2	-50	-45	1	-49		
EXPOSURE	62	42	178	98	268	149	226	:39		
WEIGHTED	63	86	356	990	2690	300	221	1400		
			7							
NCCE NO. 52 X.Y.Z COOPCIA		. LINKS 94. 76								
LIAKED TO	£.C	62	42	61	-45	-50	-35			
EXPOSURE	156	162	101	169	232	2 . 3	153			
VE16-1E0	:57	1630	204	340	233C	244	30€			
NOSE RC. 60	TOTAL	LINKS	6							
ATCREOS ZATAK	475	63	50 JUU 58	-49	-39	-41				
LINKES TO EXPOSURE	172	122	151	284	141	ΕΦ				
	1730	246	304	2650	284	170				
NODE NO41		LINKS	•							
NATAZ COSPIIN		68. 7: 55								
LINKEC TO	273	219	-39 234	-37 ea						
EXPOSURE WEIGHTED	274	5590	235	180						
NCCE 4037	TOTA	LLINKS	•	•••						
N. 7.2 CO34214			9. 290							
LINYED TO	42	38 0	-35 194							
EXPOSURE Weighted	229	2	390							
<b>6</b> 2.50120	•••									
NOCE NO. 31	TOTA	LLINKS	3							
# . V . Z CCC= CTI										
LINNED TO	151	-25 48	-28 167							
EXPCSLÄE JE IG-TED	162	158	336							
NODE 10. 4										
X.Y.Z CC0521				39	45	61	24	-19	-49	-29
LINKEC TO	27 -53	₹8 +28	62 -45	37	• • •		• •	-,	•	
EXPOSURE	113	158	169	65	64	185	32	218	208	104
EXPOSURE	227	189	123							
#E16+TED	222	316	340	132	65	372	66	438	2090	210
037+813W	2263	3 6 0	124							
NCDE AC		L LINKS	6 6. 300							
LINKEG TO	25	48	41	-45	-46	-50				
EXPOSURE	85	15	31	197	120	189				
PEIGHTED	172	:2	64	198	121	1650				
			_							
MODE 40.	e teta Bate	1 1145	300							
LINAES TS	41	1200	50	-46	-32	-46	-45	-31		
EXPOSURE	124	el	24	137	126	57	55	73		
WEIGHTED	250	£2	80	276	254	58	500	1 • 6		

## Table A.4. (cont'd)

Tubic A. T.	(001	ic u,					
ABDE NO. 50	TOTAL I	LINKS	6				
K.Y.Z CDORCINA	TE 14:	•	7.00				
LINKEC TO Exposure	53 100	90 182	54 -48		-32		
	101	182	98 132		96		
••••	•••	•••	.,	. , .	154		
	TOTAL		5				
X.Y.Z CCORDINA	TE 134						
LINKED TO EXPOSURE	53 55	110	46 -55	-57			
			69 169 70 170				
•••••	•••	•••		107			
NCDE NO46			•				
X.Y.Z CCORCINA	TE 127	2, 75,					
EINKEL TO	61 91	124 2	51 -55 19 171				
LINKEE TO Exposure Weighted	920	250 22	• • • •				
NODE NO55	TOTAL L	LINKS	٤				
X+Y+Z CCORCINA	1 L 13:	41	370 53 73	-57	••		
EXPOSURE	183	162	32 59	258	-58 272	-61 168	-48
LINKED TO EXPOSURE SEIGHTED	E40	3 C E	66 120				100
ACDE NO. 53 *+Y+Z COORDINA	TOTAL L	LINKS	3				
LINKEE TO	63	-48 -	57				
EXPOSURE	61	100 1	86				
WEIGHTED	62	100 1	87				
NCDE NC. 63	TATE: .	11.46					
N.Y.Z CCORGINA	TF 155	1. 61.	360				
LINKED TO	73	-57	61 -58				
EXPOSURE	26	242 1	57 17G				
PEICHTED	27	-57 242 19 243 3	16 342				
NOCE NO. 73			6				
X-Y-Z COORDINA							
LINKED TO		-65 -		-58	-57		
ENFCSURE	35	348 1	A1 262		151		
MEIGHTED	36	658 1	82 2630	172	152		
NOCE NO. 82	TOTAL I	ITAKS	4				
X.Y.Z COORCINA	TE 144	115.	340				
LINKES TO	93	-77 -	69 -76				
FXPUSURE	••	211 3	1- 1-				
REICHIED	65	212 3	15 166	243			
NODE NO. 93	TOTAL L	INKS	•				
X.Y.Z COORDINA	TE 147	7. 132.	330				
LINKET TO	133	-77 -	92 -75				
EXPCSURE WEIGHTED			50 183 61 1840				
4214H-150	••	302 1	0. 10.0				
RODE NO. 133	TOTAL I	LIRKS	6				
X.Y.Z COOPEINA	ITE 14	5. 146.	320		_		
LIAKED TO	90	£3 -	92 -87	-77			
LINKEC TO EXPOSURE WEIGHTEC	160	95 I	77 454	22 <b>4</b> 22 <del>5</del>	215 2160		
		•	92 -87 76 246 77 454				
NCDE NC92	TCTAL 1	LINKS	7				
X.V.Z COORDINA	TE 14	143.	330		• •		
LINKED TO EXPOSURE	183	160 1	66 295	-77 250	-76 238		
		1010 .6	50 592	251	2350	180	
NOSE NO93	TOTAL I	LI445	333				
LINKET TO		-25 -					
EXPOSURE	125		24 162				
	260		50 326				
MSCE NO85	TOTAL I	LIKKS	3				
N.Y.Z COGREINS		137.	33:				
LINKEC TO	89	52 -	81				
EXPOSUFE	296		58				
WEIGHTED 2	970	157 35	76				
NCDE NC. 92	TOTAL I	LINKS	9				
X.Y.Z CCCASINA	17E 91	1. 129.	300		_		
LINKEC TC	91	-	99 80 96 208		-78	-50	-75 239
EXPCSURE WEIGHTED	253 762	282 485		315 15600C	255 25600	196 59766	24000

Case 4 - Area 1, Route 2, Sensor Set 2.

Table A.5. Case 4 - Node Linkage for Route

				•		
FROM	EASTING	NORTHING	TC	PENALTY	EASTING	NORTHING
31	770	10150	35	164	1470	10500
35	1470	10500	-24	165	2450	9590
-24	2450	5590	-22	177	3290	5240
-22	3290	5240	32	145	2590	10250
32	2590	10290	30	220	1610	10010
30	1610	10010	28	230	560	5800
28	560	98C0 ·	. 34	185	770	10430
. 34	770	10430	45	34	70	11480
45	70		55	205	560	12390
		11460			2660	
5.5	560	12350	- :3	153		10520
-33	2660	10920	51	337	2660	11760
51	2660	11760	57	198	2940	12676
57	2940	12670	67	192	3850	13650
67	3850	13650	76	334	3920	14420
76	3520	14420	-73	302	4550	15120
-73	455C	15120	-78	261	5390	15890
-78	5390	15890	-90	201	5390	16660
-90	5390	16660	49	320	6370	16030
69	6370	16030	9 <b>9</b>	270	5810	17010
99	5810	17010	91	604	6020	16030
51	€020	16030	54	566	5250	16450
94	5250	16450	164	128	4760	17290
104	4760	17250	102	2	3710	17220
102	3710	17220	100	2	2660	17080
100	2660	17080	93	14	1610	16450
53	1610	16450	64	ž	1120	15400
£4	1120	15400	ē.	101	1120	15540
85	1120	15540	97	32	580	16590
97	980	16590	86	202	770	15690
	770	15690	98	1	1750	16870
86						
98	1750	16870	81	46	490	15190
81	490	15150	95	29	2240	16450
95	2240	16450	-66	177	3080	16590
-86	3080	16590	- 9 8	29€	3430	16590
- 98	3430	16590	- 65	167	4480	16660
-89	4486	16660	87	34 G	3590	15960
87	3990	15960	-65	29 G	4270	14350
-65	4270	14350	-56	408	3290	13300
-56	3290	13300	-63	274	3290	14280
-63	3290	14280	-74	274	3438	15120
-74	343C	15120	-82	309	3360	16030
-82	3360	16030	-59	462	1540	13930
-59	1540	13930	-71	284	1750	14910
-71	1750	14910	-53	240	2310	13160
-53	2310	13160	-43	302	2240	12180
-43	2240	12160	46	374	1750	11480
46	1750	11460	56	200	2100	12390
56	2100	12350	64	234	2100	13370
64	2100	13370	75	215	3150	14420
75	3150	14420	-72	490	2450	15050
-72	2450	15050	65	2.1	3080	13510
65	3080	13510	-64	494	2240	14260
-64	2240	14260	-64 -83	274	2870	
				_		16100
-63	2870	16100	101	98	6720	17150
101	6720	17150	-93	307	8050	17080
-93	8050	17060	-87	325	8890	16590
-87	6890	16590	96	340	9458	16450

Table A.6.	د۲	ι Δο	- Node	Lin	(200					
Table A.O.	. ca	36 4	- 11000	_ L 1111	\u y c					
NODE NC. 31	TOTAL	LINKS	7							
X.Y.Z CGCPCIA		11. 4								
LINKEC TC	34	26	3.5	3 C	-21	-23	-36			
EXPOSURE	201	158	81	119	139	180	203			
WEIGHTED	202	318	164	240	280	181	204			
		LINKS	8							
A.Y.Z CCORDIA			0. 280							
LINKED TO	30		46	2.8	-34	-38	-23	-24		
EMPCSURE	193	178	237	96	282	238	207	164		
MEIGHTED	388	358	238	199	203	478	416	165		
NCDE NO24	7074		,							
N.Y.Z CCORGIN										
LINKED TO		32	16	3.0	15	-22	-23			
EPPOSUPE	243	195	178	103	201	176	203			
WEIGHTEC	-86	156	356	206	404	177	406			
NODE NO22	TOTAL	LINKS	6							
X.Y.Z COORDIN	3141	47. 3	2. 250							
LINKED TO		24		25	32	-14				
EXPCSURE	53ء	211	171 172	190	144	235				
DE IGHTED	508	424	172	191	145	472				
			_							
NODE NO. 32										
X.Y.Z CODRCIN		3/130		-34	-36					
EXPOSURE	243	109	314	249	266					
WEIGHTES	-88	220	315	500	534					
0.000.00	- 50		3.3	3.0	304					
NCDE NC. 30	TOT41	LINKS	5							
M.Y.Z CCORDIN			3. 220							
LINKED TO		3.5		-34	-21	-33				
EXPCSURE	157	114	303	275	167	248				
MEIGHTED	116	230	60 E	275	33€	498				
		LIAKS								
X.Y.Z COORDIN			G. 200							
LINKEC TO		-21	-23							
EMPOSURE	184	536	203							
WEIGHTED	185	474	204							
NOCE NO. 34										
		LINKS								
X.Y.Z CCORCIA	ATE	11.	9, 280							
X.Y.Z CCORCIN	ATE AB	-18	-23							
X.Y.Z CCORCIA LINKED TO EXPOSURE	374 45 25	11. 4 -18 297	-23 119							
X.Y.Z CCORCIN	ATE AB	-18	-23							
X-Y-Z CCORCIN LINKEC TO EXPCSURE WEIGHTED	374 45 25 34	11. 4 -18 297	-23 119 120							
X.Y.Z CORDIN LINKED TO EXPOSURE WEIGHTED NODE NO. 45 X.Y.Z COORDIN	ATE AS 33 34 TOTAL	11 18 297 298 LINKS	-23 119 120							
NOTE A COORDING	14TE 45 33 34 TOTAL 14TE 55	11 18 297 298 298 LIAKS 1 38	-23 -23 119 120 -42							
X.Y.Z CCORCIA LINKE TO EXPOSURE WEIGHTED NODE AC. 45 X.Y.Z COORDIN LINKE TO EXPOSURE	45 45 33 34 TOTAL 4TE 55 204	11 18 297 298 LINKS 1 38 205	-23 -23 119 120 -42 -42 255							
NOTE A COORDING	14TE 45 33 34 TOTAL 14TE 55	11 18 297 298 298 LIAKS 1 38	-23 -23 119 120 -42							
X.T.Z CCORCIN LINKER TO EXPESURE WEIGHTED NODE AC. 45 X.T.Z COOPDIN LINKER TO EXPOSURE WEIGHTED	14TE 45 33 34 TOTAL 14TE 55 204 205	11+ -38 297 298 LINKS 1+ 6 -38 205 207	-23 119 120 34. 30C -42 255							
X.T.Z CCORCIA LINKEC TO EXPESSIFE WEIGHTED NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSLATE WEIGHTED NOCE AC. 55	14TE 33 34 TOTAL 14TE 55 204 205	11+ -38 297 298 - LINKS 1+ -38 205 207	-280 -23 119 120 -42 255 266							
X.T.Z CCORCIN LINKEC TO EXPOSURE WEIGHTED NODE NC. 45 X.T.Z COORDIN LINKEC TO EXPOSURE WEIGHTED NOCE NC. 55 X.T.Z COORDIN	47E 45 33 34 TOTAL 47E 55 204 205 TOTAL	11 18 297 298 . LINKS 1 38 205 207 . LINKS	-23 119 120 3 3 3 4 3 3 3 3 3 3 3 3 4 3 3 3 3 4 4 2 5 4 3 3 3 6 4 3 1 4 2 5 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	44			•		-54	-10
X.T.Z CCORCIA LINKEC TO EXPCSURE WEIGHTED NODE AC. 45 X.T.Z COOPDIN LINKEC TO EXPOSLRE WEIGHTED NOCE AC. 55 X.T.Z COORDIA LINKEC TO	14 TE 33 34 15 TOTAL 14 TE 205 15 TOTAL 14 TE 70	11+ -38 297 298 LINKS 1-38 205 207 LINKS	-280 -23 119 120 3 3 3 4. 300 -42 255 256 16	64	51	-02		-52	-54	-38
X.T.Z CCORCIA LINKEC TO EXPESSIFE WEIGHTED NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSSIFE WEIGHTED NOCE AC. 55 X.T.Z COORDIA LINKEC TO LINKEC TO LINKEC TO	147E 45 33 34 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	11 - 18 297 298 LINKS 1 - 38 205 207 LINKS	-281 -23 119 120 -42 255 256 16 -77, 240 56 -53	-34	-64	-33			_	_
X.T.Z CCORCIN LINKEC TO EXPOSURE WEIGHTED NODE NO. 45 X.T.Z COORDIN LINKEC TO EXPOSURE WEIGHTED NOCE NO. 55 X.T.Z COORDIN LINKEC TO LINKEC TO EXPOSURE	147E 45 33 34 10 10 14 16 16 16 16 16 16 16 16 16 16 16 16 16	1138 297 298 LINKS 138 205 207 LINKS -38 -38 205 207	-280 -23 119 120 3 3 64. 3 25. 25. 25. 16 77. 340 86 -53 213	-34 240	-64 176	+33 265		-52 290	-54 291	-38 187
X.T.Z CCORCIA LINKEC TO EXPESSIFE WEIGHTED NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSSIFE WEIGHTED NOCE AC. 55 X.T.Z COORDIA LINKEC TO LINKEC TO LINKEC TO	147E 45 33 34 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	11 - 18 297 298 LINKS 1 - 38 205 207 LINKS	-281 -23 119 120 -42 255 256 16 -77, 240 56 -53	-34	-64	-33			_	_
X.T.Z CCORCIN LINKED TO EXPOSURE WEIGHTED NODE NC. 45 X.T.Z COORDIN LINKED TO EXPOSURE WEIGHTED NOCE NC. 55 X.T.Z COORDIN LINKED TO LINKED TO EXPOSURE EXPOSURE	147E 45 33 34 1 TOTAL 147E 55 204 205 1 TOTAL 147E 70 -43 254 209	- 18	-281 -23 119 120 3 -42 255 256 16 -53 242	-34 240 163	-64 176 247	-33 265 152	268	290	291	167
X.T.Z CCORCIN LINKED TO EXPESSIVE WEIGHTED NODE NC. 45 X.Y.Z COORDIN LINKED TO EXPOSINE WEIGHTED NOCE NC. 55 X.Y.Z COORDIN LINKED TO LINKED TO EXPESSIVE EXPOSURE WEIGHTED WEIGHTED	133 34 15 16 16 16 16 16 16 16 16 16 16 16 16 16	1138 297 298 LINKS 138 205 207 LINKS 8159 199 263 183 264	-280 -23 119 120 3 3 3 4 - 3 25 25 25 16 -53 213 242 428	-34 240 163 241	-64 176 247 354	+33 265 152 532	268	290	291	167
X.T.Z CCORCIA LINKEC TO EXPESSIVE MEIGHTED  NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSURE WEIGHTED  NOCE AC. 55 X.T.Z COORDIA LINKEC TO EXPOSURE EXPOSURE WEIGHTED WEIGHTED  NOCE AO23	147E 45 33 39 10 10 14 15 15 20 9 20 14 15 15 16 16 16 16 16 16 16 16 16 16 16 16 16	11 39	29, 280 -23 119 120 3 3 44, 500 -42 255 256 16 77, 540 56 -51 213 242 426 486	-34 240 163 241	-64 176 247 354	+33 265 152 532	268	290	291	167
X.T.Z CCORCIN LINKEC TO EXPOSURE WEIGHTED NODE NO. 45 X.T.Z COORDIN LINKEC TO EXPOSURE WEIGHTED NOCE NO. 55 X.T.Z COORDIN LINKEC TO LINKEC TO LINKEC TO LINKEC TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WOCE NO23 X.Y.Z COORDIN	14TE	11 397 298 LINKS 6-28 207 LINKS 6-58 207 LINKS 6-59 192 263 103 103 104 105 107 107 107 107 107 107 107 107 107 107	-280 -23 119 120 3 3 44. 300 -42 255 256 16 77. 340 56 -51 242 428 486 6	-34 240 163 241 164	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
X.T.Z CCORCIN LINKED TO EXPOSURE WEIGHTED NODE NC. 45 X.Y.Z COORDIN LINKED TO EXPOSURE WEIGHTED NOCE NC. 55 X.Y.Z COORDIN LINKED TO LINKED TO EXPOSURE WEIGHTED WEIGHTED VOCE NO23 X.Y.Z COORDIN LINKED TO	14TE 33 39 11 TOTAL 14TE 70 -93 259 925 920 11 TOTAL 14TE 51	11 397 298 LINKS 1 38 2057 LINKS 8 46 - 592 263 183 264 LINKS	-280 -23 119 120 3 3-4-30C -42 255 256 256 -51 213 242 426 486 66-30C	-34 24 C 163 241 164	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
X.T.Z CCORCIA LINKEC TO EXPESSIVE MEIGHTED  NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSURE WEIGHTED  NOCE AC. 55 X.T.Z COORDIA LINKEC TO EXPESSIVE EXPESSIVE WEIGHTED WEIGHTED WOLE AO13 X.T.Z COORDIA LINKEC TO EXPOSURE WEIGHTED WEIGHTED LINKEC TO EXPOSURE TO EXPOSURE WEIGHTED WEIGHTED NOCE AO13 X.T.Z COORDIA LINKEC TO EXPOSURE	127E 45 33 39 12 12 12 12 12 12 12 12 12 12 12 12 12	11397 298 LINKS 138 206 207 LINKS 846 192 263 264 LINKS 7829	-280 -23 119 120 3 3 44. 30C -42 255 256 16 77. 34C 56 -51 213 242 428 486 6	-34 240 163 241 164 -36	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
X.T.Z CCORCIN LINKED TO EXPOSURE WEIGHTED NODE NC. 45 X.Y.Z COORDIN LINKED TO EXPOSURE WEIGHTED NOCE NC. 55 X.Y.Z COORDIN LINKED TO LINKED TO EXPOSURE WEIGHTED WEIGHTED VOCE NO23 X.Y.Z COORDIN LINKED TO	14TE 33 39 11 TOTAL 14TE 70 -93 259 925 920 11 TOTAL 14TE 51	11 397 298 LINKS 1 38 2057 LINKS 8 46 - 592 263 183 264 LINKS	-280 -23 119 120 3 3-4-30C -42 255 256 256 -51 213 242 426 486 66-30C	-34 24 C 163 241 164	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
NOTE ACOUNTY LINKER TO EXPOSURE WEIGHTED  NODE ACOUNTY LINKER TO EXPOSURE WEIGHTED  NOCE ACOUNTY LINKER TO EXPOSURE WEIGHTED  NOCE ACOUNTY LINKER TO EXPOSURE WEIGHTED WEIGHTED	147E 45 33 34 17 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	1138 297 298 LINKS 138 2057 LINKS 846 -59 263 183 264 LINKS 7829 201 404	-7, 280 -23 119 120 3 3-4, 300 -42 255 266 16 -77, 340 56 -53 242 428 486 66 274 550	-34 240 163 241 164 -36	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
X.T.Z CCORCIA LINKEC TO EXPESSIVE MEIGHTED  NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSURE WEIGHTED  NOCE AC. 55 X.T.Z COORDIA LINKEC TO EXPESSIVE EXPESSIVE WEIGHTED WEIGHTED WOLE AO13 X.T.Z COORDIA LINKEC TO EXPESSIVE WEIGHTED WIGHTED NODE AO25 X.T.Z COORDIA LINKEC TO EXPESSIVE WEIGHTED NODE NO. 51	127E 45 33 39 12 12 12 12 12 12 12 12 12 12 12 12 12	1138 297 298 LINKS 136 207 LINKS 207 LINKS 201 404 LINKS 201 404 LINKS	-280 -23 119 120 3 3 44, 500 -42 255 256 16 17, 240 56 51 213 242 426 46 274 550 7	-34 240 163 241 164 -36	-64 176 247 354 248	-33 265 152 532 153	268	290	291	167
X.T.Z CCORCIN LINKEC TO EXPOSURE WEIGHTED  NODE NC. 45 N.T.Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NOCE NC. 55 X.T.Z COORDIN LINKEC TO LINKEC TO EXPOSURE WEIGHTED  NOCE NO23 X.Y.Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NOCE NO23 X.Y.Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NOCE NC. 51 X.Y.Z COORDIN	17 TE 13 TO TAL 12 TE 13 TO TAL 12 TE 13 TO TAL 13 TE 13 TO TAL 14 TE 13 TO TAL 14 TE 14 T	11 397 298 LINKS 1 326 207 LINKS 2 326 207 LINKS 2 46 - 192 263 103 264 LINKS 29 201	-280 -23 119 120 3 3 3-4 300 -42 255 256 16 77 340 56 -51 242 428 428 466 66 300 46 274 550	-30 240 163 201 164 -36 366 367	-64 176 247 354 248	-33 265 152 532 153 -40 277 556	268 538	290	291	167
X.T.Z CCORCIA LINKEC TO EXPESSIVE MEIGHTED  NODE AC. 45 X.T.Z COORDIA LINKEC TO EXPOSURE WEIGHTED  NOCE AC. 55 X.T.Z COORDIA LINKEC TO EXPESSIVE EXPESSIVE WEIGHTED WEIGHTED WOLE AO13 X.T.Z COORDIA LINKEC TO EXPESSIVE WEIGHTED WIGHTED NODE AO25 X.T.Z COORDIA LINKEC TO EXPESSIVE WEIGHTED NODE NO. 51	127E 45 33 39 12 12 12 12 12 12 12 12 12 12 12 12 12	1138 297 298 LINKS 136 207 LINKS 207 LINKS 201 404 LINKS 201 404 LINKS	-280 -23 119 120 3 3 44, 500 -42 255 256 16 17, 240 56 51 213 242 426 46 274 550 7	-34 240 163 241 164 -36	-69 176 207 350 208 -30 323 648	-33 265 152 532 153	268	290	291	167

## Table A.6. (cont'd.)

NCDE NO. 51	7 70741	LINKS	9						
X.Y.Z COORDII	WATE	42. 6	1. 300						
LINKED TO	59	65	56	64	67	-56	-53	-43	-4
EXPOSURE	279	284	253	284	191	-56 310 311	116	261	23
WEIGHTED	560	265	508	570	102	310	676	524	23
at faulto	200	260	206	3 / 0	172	311	• 0	364	23
			_						
NODE NO. 67	TOTAL	- F1142	- 7						
X.Y.Z CCGRCII	VAIL	220 7	5. 300						
LINKED TO	76	65	59	68	75	56	-56	-65	-6
E ** 0 C C ** C					300	213	310	334	33
WEIGHTED	334	570	514	516	602	428	622	335	68
NODE NO. 76	. TOTAL	LINKS	7						
X.Y.Z COORDIN	MATE	56. 10	6, 320						
LINKED TO	75	6.8	65	-65	-63	-74	-73		
EXPOSURE	296	229	197	345	314	310	301		
WEIGHTED	5 94	2250	395	692	63C	622	302		
		/•	0.5	•					
NODE NO73	TOTAL	1 7 4 5 5	4						
X.Y.Z CCORCIA			6 4. 111						
				-75	-60	-76			
LINKEC TO									
EXPOSURE WEIGHTED	30€	307 616	361	365	369	260			
WEIGHTED	3070	616	724	726	270	261			
NODE NO78	TOTAL	LINKS	7						
X.Y.Z COORDIS	STAN	77. 12	7. 320						
LINKEL IU	94	91	85	-75	-80	-90	-69		
EXPOSURE	314	290	192	363	355	280	262		
WEIGHTED	£30	582	386	728	720	281	526		
NODE NO50	TOTAL	LINKS	4						
N.Y.Z CCOREIS									
LINKED TO	91	6.5	-89	-60					
EXPOSURE	301	159	355	343					
WEIGHTED	604		712						
ACIONIES	644	320	114	688					
			_						
NODE NO. P									
X+Y+Z CCOGCI	MATE	510 12	9. 300						
LINKED TO	51	51. 12 59 134 270	9.0	-81	-85	-75			
EXPESURE	301	134	209	363 3640	288	293			
WE IGHTED	604	270	2100	364C	289	586			
NCDE NO. 5	9 TOTAL	LINKS	2						
X.Y.Z COOPCI	NA TE	23, 14	3. 306						
LINKED TO	91	-85							
EXPOSURE	301	454							
EXPOSURE WEIGHTED	604	495C							
NCDE NC. 9	1 TOTAL	LIRES	ź						
X+Y+2 C00301									
		-75	.,						
LINKEC TO Exposure	282	258							
EXPESSIVE UE ICHTEC	504								
WE IGHTEC	-66	598							
			_						
NCDE NO. 9									
X.Y.Z CCGROII	NATE	75 • 13	5. 310						
LINKED TO	104	− è G							
EXPOSURE	63	379	335						
WEIGHTEC	63 128	379 760	335 660						
WEIGHTEC	63 128	760							
WEIGHTEC	63 128	760							
WEIGHTED NOCE NO. 10	63 128 • TOTAL	760 LINKS	660						
NCCE NC. 10: N+T+2 COOPDI	63 128 4 Total Nate	760 LINKS 68. 14	660						
WEIGHTEC  NOCE NC. 10: X+7+2 COOPGI: LINKEC TO	63 128 4 TOTAL NATE 102	760 LINKS 69. 14 -09	660						
WEIGHTEC  NOCE NC. 10 X.Y.Z COOPCII LINGEC TO EXPOSURE	63 128 4 TOTAL NATE 102 0	760 LINKS 68+ 14 -89 362	660						
WEIGHTEC  NOCE NC. 10: X+7+2 COOPGI: LINKEC TO	63 128 4 Total Nate	760 LINKS 69. 14 -09	660						
MEIGHTEC  NOCE NC. 10 X.70.2 COOPCI: LINKEC TO EXPOSURE WEIGHTED	63 128 4 TOTAL NATE 102 0	760 LINKS 68+ 14 -09 362 726	660						
MEIGHTEC  NOCE NC. 10 X.T.Z COORCI LINKEC TO EXPOSURE WEIGHTED  NODE NC. 10	63 128 4 TOTAL NATE 102 0 2	760 LINKS 63. 14 -09 362 726 LINKS	660 7. 300						
MEIGHTEC  NOCE NC. 10 X.T.Z COORCI LINKEC TO EXPOSURE WEIGHTED  NODE NC. 10	63 128 4 TOTAL NATE 102 0 2	760 LINKS 63. 14 -09 362 726 LINKS	660 7. 300						
MEIGHTEC  NOCE NC. 10 X.Y.Z COORDII LINKEC TO EXPOSURE WEIGHTED  NODE NC. 10 X.Y.Z CCORDII LINKEC TO	63 128 4 TOTAL ATE 102 0 2 2 TOTAL	760 LINKS 63. 14 -09 362 726 LINKS	660 7. 300	-89					
MEIGHTEC  NOCE NC. 10 X.Y.Z COORDII LINKEC TO EXPOSURE WEIGHTED  NODE NC. 10 X.Y.Z CCORDII LINKEC TO	63 128 4 TOTAL NATE 102 0 2	760 LINKS 63. 14 -09 362 726 LINKS	660 2 7. 100 6. 100	-89 268 536					

Table A.6.	(cont	'd.)								
NODE NC. 100 X+Y+Z CCCRDIN; LINKED TO EXPCSURE WEIGHTED			7 , 300 93 6 14	-86 230 462	-80 283 568	-83 284 285	-82 253 508			
NODE NO. 93 X-Y-Z COORCIA/ LINKED TO EXPOSURE WEIGHTED	TOTAL   ATE 2: 90 100 101	LINKS 3+ 135 55 53 108	97 71 144	86 20 42	85 17 36	84 0 2	-75 297 298	-94 133 268		
NCCE NC. 84 X-Y-Z CCORCING LINKED TO EXPCSURE WEIGHTED	TOTAL ( NE 10 85 100 101	LINKS 6. 120 86 58 116	7 81 52 106	-71 233 468	-79 216 217	-68 186 374	-84 177 356			
NODE NO. 85 X.Y.Z COCRCINA LINKED TO EXPOSURE WEIGHTED	TOTAL 1: 36 100 202	LIRKS 6+ 122 61 66 134	7 300 97 15 32	+79 234 235	-71 233 -66	-68 158 376	-84 171 356			
NODE NO. 97 X-Y-Z COGROINS LIN-ED TO EMPOSURE WEIGHTED	86	LINKS 4. 137 -84 227 456	3 -79 186 374							
NODE NO. 86 X+Y+Z CCCRSINA LINKED TC EXPOSURE WEIGHTED	TOTAL 11 61 52 182	LIRKS 1+ 127 98 0 1	, 300 -84 277 556	-71 193 368						
NODE NO. 98 X+V+2 CCOACINA LINKET TO LINKET TO EXPOSURE EXPOSURE WEIGHTED	70716 ( FE 29 -74 -22 219	.INKS - 141 -75 286 287	11 -83 240 562	-85 175 352	-91 23C 462	-88 247 496	-89 229	-82 268 522	-72 242 243	-71 225
WEIGHTED ACCE NO. E1 X-Y-Z COOPDINA LINKED TO	TCTAL I	INKS 7. 117.	14 , 306 64	-68 -53	-84	-71	-79	-59	-91	-72
LINKED TO EXPOSURE EXPOSURE WEIGHTED WEIGHTED	-64 232 242 466 486	-54 28 213 29 214	+52 191 195 192 392	261 182 262 183	261 524	259 520	23E 235	242 243	213 428	2•1 •8•
HOYOZ COSFEINA LINKED TO LINKED TO EXPOSURE	67 -74 235	75 75 -51 217	-75 -84 273	-83 -68 290	-86 -65 176	-62 281	-ee 257	-94 133	- 12 263	-71 238
	252 472 506		212 546 426	171 582 344	197 177 396	564	258	268	264	478
N.Y.Z CGORGINA LINKEC TO EXPOSURE WEIGHTEC NCOE NO!A	87 169 340	-58 -58 255 256	-83 315 632	-82 314 630						
Novez CCCRDINA LINKED TO EXPOSURE WEIGHTED		-62 351 704		-29 166 167						
RCDE MCE9 N.Y.Z CCORCINA LINKEL TO EXPCSUAE WEIGHTED		IAKS - 136 -60 263 568	2336							

Table A.6	. (co	nt'd.	)							
	•		,							
NCDE PC. 8	7 TOTAL		14 28. 330							
LINKEL TO	75	77	76	71	-62	-80	-74	-83	-75	-65
LINKES TO	-72	-43	-79	-64						
EXPOSURE EXPOSURE	276 251	257	247	234	353	338	330	319	303	285
WE IGHTED	554	277 2580	254 496	262 2350	70€	678	662	648	603	290
WEIGHTED	584	556	510	526				• • •		• • • •
	·		_							
NODE NO6										
LINKEE TO	6.8	7,7	-63	-74	-56					
EXPCSURE	314	304	318	313	203					
MEIGHTED	3150	610	638	628	4 C E					
NODE NO5	6 TOTAL	ITVES	5							
F. V. 2 COOPDI			0. 310							
LINKES TO			-63	-53	-64					
EXPCSURE deighted	292 586	258	273	252	246 494					
#2 10F 'EU	266	518	274	506	777					
NODE NO6	3 TOTAL	LINKS	5							
X.Y.Z COORCI			330		<u>.</u> .					
LINKES TO EXPOSERE	75 31e	65 229	-74 273	-64 255	-72 244					
WEIGHTED	638	+20	274	512	493					
			• • •							
NODE AC7			. •							
LINKEZ TO	75	45. 11 -62	-72	-63						
EXPCSUPE	269	306	281	239						
REICHTED	540	309	564	480						
NODE NO5 X.Y.Z COORDI			13 9. 358							
LINKED TO	75	77	-63	-80	-72	-79	-71	-64	-75	-59
EXPOSURE	275	2:3	342	305	106	279	265	277	273	230
MEIGHTED	560	2348	686	612	<b>61</b> E	560	532	55€	546	462
100E NC!	. 10742	LINKS	ę							
X.Y.Z CCORCE	MATE	22. 9	9. 350							
LINKEE TG	64	70	-5•	-64	-71	-68 244	-53 193	-52 283		
EXPOSURE UEIGHTED	246	262 526	32: 642	343 <b>34</b> 4	263 264	490	366	428		
			• • •	•	-					
NODE NC7	1 TOTAL	LIARS	15							
M.Y.Z CCORDI LINKED TO	441E 75	25 1:	70	65	55	-72	-64	-79	-68	-83
LINKEC TO	-54	-53	-64	-52	-91	- 1.			••	••
EXPOSURE	271	245	220	226	185	309	326	273	245	563
EPPOSUSE	237	239	216	\$65	161			274	452	264
MEIGHTED MEIGHTED	476	246	45e	456	3 g G 3 6 4	620	614	214	474	<67
45 107 165	***			•••	•••					
NOCE NO5										
X.Y.Z CCCRSI		33. *		-43						
LINKED TO Exposure	343	174	65 192	150						
MEIGHTEC	488	350	386	302						
			_							
NODE AC4	S TOTAL	12. 1	4 110							
LIAMEC TO	. 56			-54						
EXPOSURE	267	104		222						
REIGHTEC	526	374	436	446						
NSCE AC	4 TOTAL	LINKS	•							
X. V.Z CCCRCI										
LINKED TO		-34	-44	-35						
E APOSURE BEIGHTEC	199 200	234 470	253 506	138 276						
MODE NC. 5										
X.V.Z COCADI		38. 7	77. 210 -54							
EXPOSURE	233	223	220							
METENTED	234	446	442							

Table A.6	5. (c	ont'd.	.)							
NODE NO.		L L1K45								
LINKEC TO	65	75	+54	-64						
ENPOSURE	260	218	322	345						
WEIGHTED	522	219	546	345						
ar 100.100	466	217	246	3-5						
NCDE NC.	76 7074	L LINKS								
X.Y.Z COOPD			3,30							
LINKEC TO			CE • 330							
EXPOSURE	65	-64	-72							-
	273	318	244							
MEIGHTED	546	638	490							
		L LINKS								
X.Y.Z COSECI			15. 350							
LINKEC TO	65	7.0	-64	-75		-68	-54	-52		
EXPOSURE	228	225	345	311	324	245	2 • 8	205		
WEIGHTED	629	460	692	624	325	492	498	412		
		L LINKS	2							
X.Y.Z COORCI	INATE	44.	93. 310							
LINKED TO	<b>.</b> 5	-64								
EXPOSUPE	289	246								
<b>b</b> E [GhTED	560	454								
		L LIAKS	9							
X.Y.Z CCCRCI	INATE	27. 1	044 150							
LINKED TO	70		-54	-69	- 79	-63	-52	-44	-84	
EXPOSURE	250	244	28€	257	274	273	227	196	177	
MEIGHTED	502	450	574	516	275	274	456	354	356	
			•		• • •	• • •	4,50	3,4	336	
NODE 1.08	3 TOTA	L LINKS	20							
X . Y . Z CGORDI	NATE	41. 1								
LINKET TO	77	6.6	7 û	76	55	71	ع >	101	79	72
LINEEC TO	6.0	62	52	-79	-00	-94	-75	-84	-68	-
LINKED TO	-54	-52	-40	-44	-41	-42	-49	-39	-00	-51
EXPCSURE	273	266	216	269	233	271	248	97	204	201
EXPESURE	184	173	167	286	301	157	293	237		
EXPESURE	232	204	206	184	226	158	188	167	226	227
WEIGHTED	2740	2670	434	540	234	2720	498	78	2050	
HEIGHTED	1450	1840	1680	574	604	316	588			5050
MEIGHTED	466	410	207	370	454	318		476	454	456
	• • •		•••	• . •	7.7	310	1870	1680		
SCDE NO. 10	1 TOTAL	LLINKS	8							
M.Y.Z CCOPDI			5. 300							
LINKED TO	9.8	~ ap*	83	-85	-81	-93	-75	-83		
E*POSURE	306	271	259	346	376	306	222			
JEIGHTED	3070	2720	2600	594	3770			286		
JE 10F 100	30.6	2 - 2 0	2000	777	3.10	307	446	574		
406E 409.		LIANS								
TAMES TO		115, 14								
LINKED TO	90	-65	-97	-61						
EYPOSURE	194	255	324	210						
PEIGHTED	1550	512	325	+22						
	<b></b>									
		LINKS	6							
X . Y . Z CCORDII		127, 13								
LINKED TO	96	90	8.8	-92	-76	-77				
EXPOSURE	239	525	195	171	520	289				
ue ighted	340	126560	71500	7200	69300	21006				

Case 5 - Area 2, Route 1, Sensor Set 1.

Table A.7. Case 5 - Node Linkage for Route

FROM	EASTING	NORTHING	TO	PENALTY	EASTING	NORTHING
3	3820	7280	9	1	4870	7630
9	4676	7630	13	1	4450	8470
13	4450	2470	7	50	5290	7630
7	5290	7630	-2	4 C	4240	7280
-2	4240	7260	11	202	4100	7980
2.1	4100	7580	31	17	2560	5870
31	2560	9870	37	2	3470	10640
! 7	3470	10640	32	37	4240	10080
32	4240	10080	36	52	5290	10640
16	5290	10640	35	160	4730	10430
35	4730	10430	46	54	5500	11270
46	5500	11270	36	10£	6340	10710
36	6340	10710	33	36	5500	10150
33	5500	10150	-21	£6	5C10	9100
-21	5010	5100	12	24	5430	8190
12	5430	£190	22	38	5570	9170
2.5	557C	5170	26	90	3610	5660
26	3610	9660	19	€ 0	4100	9100
19	4100	9100	-23	72	3120	9240
-23	3120	9240	23	3	4170	9240
23	4170	9240	42	34	2980	11060
42	296¢	11060	34	64	2280	10360
3.4	2280	10360	5.6	c é	2630	12320
. 56	2630	12320	50	5.6	3260	11550
50	3560	11550	57	118	3690	12390
5.7	3890	12390	-62	2	2640	13090
-62	2840	13090	70	166	2210	14000
70	2210	14000	£ 2	٤٤	2560	14510
£2	2560	14910	-76	236	2510	14420
-76	2910	14420	-71	492	2700	13720
-71	2700	13720	-52	€2	4650	11830
-52	4660	11830	45	65	5150	11270
45	5150	11270	65	10	7180	13230
65	7160	13230	71	20	<b>ECS0</b>	14140
71	£020	14140	79	£ 4	£790	14560
79	8790	14560	€1	1 ÷ C	9560	14770

Table A	.8. Ca	se 5 -	Node	Lini	cage					
	3 TOTAL		. 350							
X.Y.Z COOR		25. 8	9 9	- 2	-1					
EXPOSURE	11 75	148	ō	148	206					
WI LGHTED	152	298	i	149	414					
		_	_							
NOCE NO.	9 TOTAL		. 290							
X . Y . 7 COOR	DINATE 7	41, 5	11	13	-2					
EXPOSURE	147	75	65	D	137					
ME TENTED	100	152	132	1	276					
NODE NO.	13 TOTAL	25. 21	. 290							
X.Y.Z CCOF	CINAIL 11	19	23	12	7	-21				
LINKER TO EXPOSURE	124	79	67	53	24	155				
WEIGHTED	250	PG	8.6	54	50	314				
ACDE AG.	7 101AL	. LINKS 9	. 380							
LINKEC TO	12	-10	-2	-12						
EXPOSURE	100	234	19	210						
ME IGHTED	202	235	4 0	519						
NCDE AC.	-2 TOTAL		310							
X.Y.Z COO	PDINATE 11	32.	,, ,,,							
EPPGSUPE	100	176								
WE IGHTED	202	274								
••••		_								
ACRE AC+	11 TOTAL	FILLE	21							
x . Y . 2 CCO	RDINATE 19	23	8	12	18	28	22	32	31	-13
LINKED TO		-21	-23	-26	- 3	-18	-1 C	-12	-24	-20
LINKEC TO		• •						39	16	149
EXPCSUPE	91	98	185	92	95	44	103 236	240	145	243
EXPOSURE	195	134	71	278	269	217	200	• • •		
	244								17	300
EXPOSURE		166	372	93	74	65	20 F	60		
WEIGHTED	184	198 279	372 92	93 558	96 128	436	20 F 235	241	292	244
UF IGHTED UE IGHTED		178 276								
uf ighted ue ighted ue ighted	184 192 490	274	92							
WEIGHTED WEIGHTED WEIGHTED NOOE NO.	184 392 490 31 1074	278	92							
WEIGHTED WEIGHTED WEIGHTED NOOE NO. X+Y+Z COO	184 292 490 31 TOTAL RCINATE	274   LJAKS   80 43	92							
WEIGHTED WEIGHTED WEIGHTED WOOE NO. X+Y+Z COO LINKES TO	189 292 490 31 Total Reinate 34	278	92	558	128	+36				
WEIGHTED WEIGHTED WEIGHTED WOOE NO. X.Y.Z.COO LINKED TO EXPCSURE	184 292 490 31 TOTAL RCINATE	276 LINKS 2, 43	92 6 200 28	37	-24	+36				
WEIGHTED WEIGHTED WEIGHTED WOOE NO. X+Y+Z COO LINKES TO	189 392 490 31 TOTAL RCINATE 34 100	276 LINKS 2. 43 18 64 130	92 6 78 19 20	37 C	-24 225	-23 ec				
WEIGHTED WEIGHTED WEIGHTED WOOE NO. MATTA COO LINKED TO EXPCSURE WEIGHTED ROOE NO.	189 292 990 31 TOTAL RCINATE 34 103 101	276 LINKS 2, 43 10 64 130 LLIMAS	92 6 7300 73 19 20	37 C	-24 225	-23 ec				
WEIGHTED WEIGHTED WEIGHTED WOOE NO. MYTWOOD TO EMPCSURE WEIGHTED NODE NO. X*Y*Z CCC	189 292 490 31 TOTAL RCINATE 54 100 101 37 TOTAL FCINATE	276 LJAKS 2. 43 10 64 130 LLIMES 21, 51	92 6 300 28 19 20 7	37 0 2	-24 225 452	-23 ec e1				
WEIGHTED WEIGHTED WEIGHTED WOODE NO. MOTOZ COO LINKES TO EXPOSURE WEIGHTED NODE NO. X-Y-Z COO LINKES TO	186 192 690 31 TOTAL RCINATE 36 101 101 37 TOTAL RCINATE	276 LINKS 2, 43 10 64 130 LLINKS 21, 53	92 6 300 28 19 20 7	37 C	-24 225	-23 ec	235			
WEIGHTED WEIGHTED WEIGHTED WODE # 0.  ***********************************	184 192 490 31 TOTAL RCINATE 34 103 101 37 TOTAL FCINATE 42 100	276 LJAKS 2. 43 10 64 130 LLIMES 21, 51	92 6 300 28 19 20 7	37 C 2	-24 225 452	-23 -25 -21	235			
WEIGHTED WEIGHTED WEIGHTED WOODE NO. MOTOZ COO LINKES TO EXPOSURE WEIGHTED NODE NO. X-Y-Z COO LINKES TO	184 392 490 31 TOTAL RCINATE 34 103 101 37 TOTAL FCINATE 42 103 202	276 LINKS 2, 43 18 64 130 LINKS 21, 5: 40 40 42	92 6 300 28 19 20 7 20 32 36 37	37 C 2	-24 225 452 -40 255	-23 -25 -21 -41 182	235 -48 98			
WEIGHTED WEIGHTED WOOE NO. MOTOZ COU LINNED TO ENPCSJEE WEIGHTED NODE NO. X.Y.Z COU LINKET TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 103 101 97 TOTAL FCINATE 42 103 202	276 LINKS 2	92 6 300 28 19 20 7 300 32 36 37	37 C 2	-24 225 452 -40 255	-23 -25 -21 -41 182	235 -48 98			
WEIGHTED WEIGHTED WOOE NO. MOTOZ COU LINNES TO EXPCSURE WEIGHTED NODE NO. MAYAZ COU LINKES TO EXPCSURE WEIGHTED WEIGHTED WEIGHTED WCDE NC. MAYAZ COU LINKES TO EXPCSURE WEIGHTED	189 292 490 31 TOTAL RCINATE 34 102 101 97 TOTAL FCINATE 42 102 202 32 TOTAL FCINATE	276 LINKS 8, 42 130 LINKS 21, 53 40 42 LINKS	92 6 300 28 19 20 7 2. 300 37 36 37	37 C 2	-24 225 452 -40 255 512	-23 20 81 -41 182 366	235 -48 98			
WEIGHTED WEIGHTED WEIGHTED WOODE NO. LINNES TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 37 TOTAL FCINATE 102 202 32 TOTAL FCINATE	276 LINKS 2, 43 10 64 130 LINKS 21, 53 40 40 42 LINKS 32, 42	92 6 300 28 19 20 7 300 32 36 37	37 C 2	-24 225 452 -40 255	-23 -25 -21 -41 182	-48 93 178	241	-21 e=	
WEIGHTED WEIGHTED WOOE NO. MOVE NO. LINKES TO EXPOSURE WEIGHTEC WEIGHTEC WEIGHTEC WEIGHTEC WEIGHTEC WEIGHTEC WEIGHTEC WEIGHTEC TC EXPOSURE WEIGHTEC TC EXPOSURE	189 292 490 31 TOTAL RCINATE 34 102 101 97 TOTAL FCINATE 42 102 202 32 TOTAL FCINATE	276 LINKS 8, 42 130 LINKS 21, 53 40 42 LINKS	92 6 300 24 19 20 7 300 37 36 37 36 37	37 C 2 28 28 58	-24 225 452 -45 255 512	-23 20 81 -41 182 366	-48 98 178	241 -41	-21	
WEIGHTED WEIGHTED WEIGHTED WOODE NO. LINNES TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 37 TOTAL FCINATE 42 102 202 32 TOTAL FCINATE 116 234	276 LINKS 2. 42 130 LINKS 21. 5: 40 40 42 LINKS 22. 28 52 166	92 6 20 19 20 7 20 37 36 37 4 300 23 79	37 C 28 28 28 38	-24 225 452 -40 255 512	-23 20 21 -41 182 366	-40 93 178		-21 e=	
WEIGHTED WEIGHTED WOOE NO. MOTOZ COU LINNED TO EXPCSURE WEIGHTED WOOE NO.	189 192 490 31 TOTAL RCINATE 34 103 101 37 TOTAL FCINATE 42 102 202 32 TOTA FCINATE 116 234	276 LINKS 2. 42 130 LINKS 21. 52 40 40 42 LINKS 22. 46 52 186	92 6 . 300 24 19 20 7 36 37 4 . 100 23 79 150	37 C 28 28 28 38	-24 225 452 -40 255 512	-23 20 21 -41 182 366	-40 93 178		-21 e=	
WEIGHTED WEIGHTED WOOE NO. MOOE NO. LINKED TO EXPCSURE WEIGHTEC MODE NO. LINKED TO EXPCSURE WEIGHTED WCDE NC. LINKED TO EXPCSURE WEIGHTED WCDE NC. MODE NC.	189 192 490 31 TOTAL RCINATE 34 103 17 TOTAL FCINATE 42 103 202 32 TOTA FCINATE 116 234 36 TOTA 973112TE	276 LINKS 2. 42 130 LINKS 21. 53 40 42 LINKS 22. 28 52 186 LINKS	92 6 . 300 28 19 20 7 . 300 37 4 . 300 23 79 160	37 C 2 28 28 38	-24 225 452 -40 255 512	-23 -23 -20 -21 182 366			-21 e=	
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 27 TOTAL FCINATE 102 202 32 TOTAL FCINATE 116 234	276 LINKS 20 62 130 LINKS 210 62 LINKS 220 62 LINKS 220 126 LINKS 230 72 LINKS	92 6 . 300 28 19 20 7 . 300 37 4 . 300 23 79 160	37 C 28 28 28 38	-24 225 452 -40 255 512	-23 20 21 -41 182 366	-40 93 178		-21 e= 132	-43
WEIGHTED WEIGHTED WOOE NO. MOVEZ COOLINKES TO EXPOSURE WEIGHTED	189 192 490 31 TOTAL RCINATE 34 100 101 37 TOTAL FCINATE 42 102 32 TOTA FCINATE 234 36 TOTA 90IN:TE 237	276 LINKS 20 64 130 LINKS 210 64 210 LINKS 210 62 LINKS 220 64 28 126 LINKS 270 726	92 6 . 300 28 19 20 7 . 300 37 4 . 300 23 79 160	37 C 2 28 28 38	-24 225 452 -40 255 512	-23 -23 -20 -21 182 366			-21 65 132	244
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 27 TOTAL FCINATE 102 202 32 TOTAL FCINATE 116 234	276 LINKS 20 62 130 LINKS 210 62 LINKS 220 62 LINKS 220 126 LINKS 230 72 LINKS	92 6 . 300 28 19 20 7 . 30C 37 36 37 9 . 30C 23 79 152 12 2. 300 45	28 28 28 38 29 39 29 29 29 29 29 29 29 29 29 29 29 29 29	-24 225 452 -40 255 512 36 25 52	-23 -23 -20 -41 182 366 -26 308 309	-40 93 170 -40 204 , 410	-41 208 418 -29	-21 65 132	-03
WFIGHTED WEIGHTED WEIGHTED WOOE NO. ANTOZ COOLINKED TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 100 101 37 TOTAL PCINATE 42 102 32 TOTA FCINATE 234 36 TOTA 90IN:TE 256 31F	276 LINKS 2	92 6 7 20 7 20 7 20 37 36 37 4 4 150 25 79 150 12 24 45	37 C 2 28 28 58 19 39 20 46	-24 225 452 -40 255 512 36 25 52	-23 20 21 182 366	-ae 93 176 -a0 20a , a10		-21 e= 132	-43
WEIGHTED WEIGHTED WEIGHTED WOOE NO. AVT-Z COO LINKED TO EXPOSURE WEIGHTED WEIGHT	184 192 490 31 TOTAL RCINATE 34 101 27 TOTAL RCINATE 42 102 202 32 TOTAL FCINATE 35 116 234 255 257 257 257 257 257 257 257 257	276 LINKS 2. 19 54 130 LINKS 21. 60 40 42 LINKS 32. 28 52 156 LINKS 22. 28 52 26 67 27 28 28 27 28 27 28 27 28 27 28 27 28 27 28 27 28 27 28 27 28 27 28 27 28 28 27 28 27 28 27 28 27 28 27 28 27 28 28 28 28 28 28 28 28 28 28 28 28 28	92 6 . 300 28 19 20 7 . 30C 37 36 37 9 . 30C 23 79 152 12 2. 300 45	28 28 28 38 29 39 29 29 29 29 29 29 29 29 29 29 29 29 29	-24 225 452 -40 255 512 36 25 52	-23 -23 -20 -41 182 366 -26 308 309	-40 93 170 -40 204 , 410	-41 208 418 -29	-21 65 132	-03
WFIGHTED WEIGHTED WEIGHTED WOOE NO. LINNEG TO EXPCSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 27 TOTAL RCINATE 42 202 32 TOTAL FCINATE 116 234 35 TOTAL FCINATE 116 235 36 TOTAL 36 TOTAL 37 TOTAL 38 TOTAL 3	276 21	92 6 . 300 28 19 20 7 . 30C 37 36 37 9 . 30C 23 79 152 160 322	28 28 28 38 29 39 29 29 29 29 29 29 29 29 29 29 29 29 29	-24 225 452 -40 255 512 36 25 52	-23 -23 -20 -41 182 366 -26 308 309	-40 93 170 -40 204 , 410	-41 208 418 -29	-21 65 132	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 103 101 37 TOTAL FCINATE 42 100 202 32 TOTA FCINATE 116 234 36 TOTA 9011112 256 316 317 317 317 317 317 317 317 317 317 317	276 LINKS 2	92 6 7 28 19 20 7 2. 30C 37 36 37 4. 30C 25 79 150 12 2. 30C	28 28 28 38 29 39 29 29 29 29 29 29 29 29 29 29 29 29 29	-24 225 452 -40 255 512 36 25 52	-23 80 81 -41 182 366 -26 309 47 166		-41 208 418 -29	-21 65 132	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. AVTOZ COOLINNES TO EXPOSURE WEIGHTED WCDE NC. LINKES TO EXPOSURE WEIGHTED WOOE NC. LINKES TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WOOE NC. AVTOZ COOLINNES TO LINKES TO LINK	189 1992 1992 1993 31 TOTAL RCINATE 100 101 37 TOTAL FCINATE 102 102 32 TOTAL FCINATE 116 234 35 TOTAL PCINATE 256 31e 502 35 TOTAL PCINATE 256 31e 502 35 TOTAL PCINATE 257 256 31e 502 35 TOTAL PCINATE 257 258 258 258 259 257 257 258 258 258 258 258 258 258 258 258 258	276 LINKS 2. 63 18 64 130 LINKS 21. 60 40 42 LINKS 32. 60 42 LINKS 32. 60 42 LINKS 32. 60 42 LINKS 32. 60 42 LINKS 47. 50 48 48. 60 48.	92 6 7 28 19 20 7 36 37 9 152 25 79 160 322 5 300 45 160 322	28 28 28 58 19 39 87 87 87 87 87 87 87 87 87 87 87 87 87	-24 225 452 -40 255 512 36 25 52	-23 ec e1 182 366 -26 308 309 47 166	-40 92 170 -40 204 , 410	-41 208 418 -29	-21 65 132	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED	184 192 490 31 TOTAL RCINATE 34 101 37 TOTAL PCINATE 42 102 32 TOTAL FCINATE 116 234 36 TOTAL PCINATE 235 317 159 250 317 CREINATE 331 CREINATE 331 111	276 LINKS 2. 10 64 130 LINKS 2. 60 40 42 LINKS 22 126 47 52 126 LINKS 23 126 47 52 126 48 231 160 48 123	92 6 7 20 7 20 7 20 37 36 37 4 4 150 122 23 79 150 160 322	37 C 2 28 28 58 19 39 20 11 2 2 3 8 2 6 5 6 7 1 2 6 8 2 6 8 7 1 2 6 7 1 2 6 7	-24 225 452 -40 255 512 36 25 52 161 1820	-23 20 21 182 366 -26 208 309 47 166 1676	-ae 93 170 -a0 20a .a10	-41 208 418 -29	-21 65 132	-03
WFIGHTED WEIGHTED WEIGHTED WOOE NO. AVT.Z COOLINECT TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED WOOE NO. LINKED TO LINKED TO LINKED TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WOGE NO. RATOZ COLINKED TO LINKED TO LINKED TO LINKED TO LINKED TO LINKED TO	184 192 490 31 TOTAL RCINATE 34 101 37 TOTAL RCINATE 42 102 202 32 TOTA FCINATE 35 116 234 251 152 257 153 257 153 257 153 257 153 257 153 257 153 257 257 257 257 257 257 257 257 257 257	276 LINKS 2. 19 54 130 LINKS 2. 40 40 40 42 LINKS 52 166 47 16 47 16 48 18 18 18 18 18 18 18 18 18 18 18 18 18	92 6 7 28 19 20 7 36 37 9 152 25 79 160 322 5 300 45 160 322	28 28 28 58 19 39 87 87 87 87 87 87 87 87 87 87 87 87 87	-24 225 452 -40 255 512 36 25 52	-23 ec e1 182 366 -26 308 309 47 166	-40 92 170 -40 204 , 410	-41 208 418 -29	-21 65 132	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. X.Y.Z.COO LINKES TO EXPCSIZE WEIGHTED	189 192 490 31 TOTAL RCINATE 34 101 37 TOTAL RCINATE 42 102 202 32 TOTAL FCINATE 254 251 25 TOTAL CREINATE 256 316 257 153 27 153 27 153 27 153 27 153 27 153 28 21 27 153 21 27 153 21 27 153 21 27 153 21 27 153 21 27 153 21 27 153 21 27 153 21 27 153 21 27 27 153 28 28 28 28 28 28 28 28 28 28 28 28 28	276 21	92 6 7 20 7 20 7 20 37 36 37 4 4 150 122 23 79 150 160 322	37 C 2 28 28 58 19 39 20 11 2 2 3 8 2 6 5 6 7 1 2 6 8 2 6 8 7 1 2 6 7 1 2 6 7	-24 225 452 -40 255 512 36 25 52 161 1820	-23 20 21 182 366 -26 208 309 47 166 1676	-ae 93 170 -a0 20a .a10	-41 208 418 -29	-21 65 132	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE	184 192 490 31 TOTAL RCINATE 34 102 101 37 TOTAL FCINATE 42 102 202 32 TOTA FCINATE 116 234 36 TOTAL POINTE 256 318 257 311 112 44 TOTAL	276 LINKS 2. 19 14 130 LINKS 21. 60 40 42 LINKS 52 186 47 186 LINKS 28 128 47 186 48 123 186 48 123 186 48 123 186 48 123 186 187 187 188 188 188 188 188 188 188 188	92 6 7 19 20 7 36 37 36 37 4 300 23 78 159 160 322 24 25 300 45 160 322 25 300 45 300 45 300 45 400 400 400 400 400 400 40	37 C 2 28 28 58 19 39 29 11 2 2 3 8 2 5 3 2 5 2 5	-24 225 452 -40 255 512 36 25 52 161 1820	-23 20 21 182 366 -26 208 309 47 166 1676	-ae 93 170 -a0 20a .a10	1 208 29 201 484	-21 65 132 -01 205 412	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPESSIVE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEOE NO. LINKED TO EXPOSURE WEIGHTED WIGHTED WIGHTED WEIGHTED WIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TE EXPOSURE WEIGHTED WOOE NO. LINKED TE ACOE	184 192 490 31 TOTAL RCINATE 34 103 101 37 TOTAL FCINATE 42 102 202 32 TOTA FCINATE 234 36 TOTAL POINTE 256 316 277 275 256 316 277 275 276 276 277 277 277 277 277 277 277 277	276 LINKS 2. 19 14 130 LINKS 21. 60 40 42 LINKS 52 186 47 186 LINKS 28 128 47 186 48 123 186 48 123 186 48 123 186 48 123 186 187 187 188 188 188 188 188 188 188 188	92 6 7 19 20 7 36 37 36 37 4 300 23 78 159 160 322 24 25 300 45 160 322 25 300 45 300 45 300 45 400 400 400 400 400 400 40	28 28 28 58 19 39 87 87 87 87 87 87 87 87 87 87 87 87 87	-24 225 452 -40 255 512 36 25 52 101 1820	-23 20 81 182 366 -26 308 309 47 166 1670	-40 92 170 -40 204 -410 -32 272 273 -27 236 239	-41 208 918 -29 201 484	-21 65 132 -41 412	-03
WEIGHTED WEIGHTED WEIGHTED WOOE NO. LINKED TO EXPOSURE	189 1992 490 31 TOTAL RCINATE 34 101 37 TOTAL RCINATE 42 102 202 32 TOTAL FCINATE 35 116 234 251 152 257 153 25 TOTAL CREINATE 256 318 257 277 153 211 112 277 276 276 277 277 277 277 277 277 27	276 LINKS 2. 10 54 110 LINKS 21. 5; 40 42 LINKS 22. 28 72. 126 LINKS 23. 126 LINKS 24. 126 LINKS 25. 126 LINKS 26. 126 LINKS 26. 126 LINKS 27. 136 LINKS 27. 136	92 6 7 19 20 7 36 37 36 37 4 300 23 78 159 160 322 24 25 300 45 160 322 25 300 45 300 45 300 45 400 400 400 400 400 400 40	28 28 28 38 29 39 39 80 46 11e 238 -46 258 538	-24 225 452 -40 255 512 36 25 52 161 1620	-23 20 81 182 366 -26 309 47 166 1676	- 40 - 40 204 - 410 - 32 272 273 273 273	1 208 29 201 484	-21 65 132 -01 205 412	-03

Table A.8.	(c	ont'd.	)							
NADE NO. 38		L LINKS	A 53. 340							
LINKER TO	47	3.3	27	- 39	-32	-43	-37	-27		
EMPOSURE	195	17	245 494	535	271	200	32 c	237		
w: IGHTFD	392	36	474	466	544	402	321	476		
		L LINKS	ę							
* . Y . Z COOPDIN		50 · 4	5. 330	••	••					
LINKEC TO Expessore	27	327	-32 291	-26 287	-35 186	-21 27	-43 145	-41 167		
MEIGHTED	100	6.76	292	576	374	56	300	336		
NOCE NO21	***									
**A*S COOSOIV	ATE	L LIAKS								
LINKES TO	22	23	19	12	-26	-27				
i sou chat	150	4.6	19	16	320	250				
PETCHIED	155	5.6	4 C	34	662	502				
		L LINES	4							
- X+Y+Z CCORDIN: - LINKED TO	ATE 22	49. 1 -12	17. 300 -10	- 20						
EVENSURE	18	315	30#	-20 227						
WEIGHTED	3.0	315	305	456						
NODE NO. 22	* * * *	LLINKS	23							
* +Y+Z COORDING			330							
LINKET TO	27	15	23	19	2 6	45	2	4	-27	-20
LIMMES TO LIMMES TO	-26	-12	-32	-10	- 35	- 8	-1 -	-28	-31	-+3
EXPOSURE	307	-49 267	-36 74	54	44	134	76	69	340	327
EXPOSURE	314	290	301	279	206	253	261	275	289	191
EXECUTE	189	174	563							
WEIGHTES WEIGHTED	30A 630	268 562	15 C 6 C 4	110 550	90	210	154	140	682	328
WE IGHTED	190	175	2610	336	416	508	365	276	2900	384
			_							
NODE NO. 29 Novez Coordina		L LIAKS	6. 300							
LINKET TO	23	19	1 A	-23						
LYPCSURE	125	. 9	95	195						
WEIGHTED	126	60	192	392						
		LLINKS	•							
M.Y.Z CCORDIN			0. 290							
LINKET TO Exposure	23 106	-26 260	-23 35	-13 39						
WEIGHTED	265	522	72	e c						
			5							
NUCE NO. +23 N.Y.Z COORDING		16. 3								
L: 4 4 E D TO	18	23	-24	-13	-18					
EXPOSURE	119	?	15.		187 376					
et 16+1EC	249	3	310	154	316					
		L LINKS								
PATAZ CODEDINA LINKED TO		31. 3	42	34	45	• 7	-26	-13	-27	-40
LIAKET TO	18 -91	- ; •	-50	-18	-1	- 25	-12	-13	-39	- 5
LINKED TO	-+2	-47								
EXPOSURE	97	137	3: 272	32	168	166	336	113	256 179	216 169
EYPCSURE EYPOSUFE	219	173 169	212	2 2 E	131	264	246	240	117	167
WF 1GHTEC	196	276	3.	66	218	1670	662	228	297	434
WEIGHTED	440	148	213	458	264	530	249	241	360	380
MEIGHTED	210	1700								
		LLINKS	, ,							
MAYAZ CCORDIN		144 5	9. 300	-42	-45	-40	-48			
EINKET TO	130	73	34 31	153	132	166	56			
BEIGHTED	505	76	64	308	266	9.7.8	158			
NOCE NO. 34	1014	LINKS	12							
X+Y+Z CCCRDIN			e• 1500							
LINKES TO	52	16	50	56	57	-42	-45	-24	-18	- • 0
618482 70 Carconhe	-48.	-13 79		, .	56	198	162	207	236	205
E+FCSUME ExFCSUME	122	62	58	33	36	170			. 30	-43
METGHTEC	124	160	110	6.6	116	199	183	416	478	+15
M. ICHTEC	246	126								
NEDE NO 56	TOTA		5							
N.T.Z CCGRCIN			300	- 4 =	- 5 9					
LINKER TO Expessible	52 188	50 28	-62 160	-45 114	98					
MEIGHTED	505	29	355	230	198			•		

<b>*</b> 13. A 0	,		`							
Table A.8.	(cc	ent a.	)							
		LIAKS	4							
X.Y.Z CGORGINA LINKED TO	TE 52	18+ 6	-4 P	G -•¢						
	100	58	151	192						
WEIGHTED	202	118	30◆	193						
NCDE NC. 57	TOTA	LLINKS	6							
X.Y.Z CCOPDINA			17. 331	9						
LINKED TO	60	-59	-46	-52		-62				
	101 204	100 202	75 152	48		0 2				
NODE NO62 Navaz Coordina		L LINKS 12• B	3 17 <b>。</b> 351							
LINKES TO	70	-71	-59							
EXPOSURE	F 2	219	165							
WFIGHTED	166	200	335							
NCDE NO. 70	TOTA	LLINKS	3							
X+Y+Z CCORDINA			0. 330	0						
LINKED TO Exposure	P 2	-71 279	-76 175							
WEIGHTED	8.6	560	1760							
11005 AO 00			,							
NCCE NO. 82 X.Y.Z COOFCINA		6 LIRKS	.3. 33(	0						
LIBREC TO	95	€4	96	-76		-74				
	142	145	90	237		219				
METCHLED	286	1460	516	526	1930	2200				
		LINKS	•							
X.Y.Z CCOPDINA Linked to	TE 64	13, 10 -78	-74	) -71						
EPPOSURE	96	242	279	245						
	570	2430	2800	492						
ACDE PC71		LINKS	13							
N.Y.Z CCORDINA		10. 9		)						
	75	64	52	72	60	-74	-78	-59	-64	-67
•	-79 1 <b>9</b> 9	-4 @ 200	-52 •3	167	102	253	231	149	223	365
	152	75	61			•••		•		
	000	2010	66	1580	1030	2540	2320	150	448	3060
PEIGHTED 1	530	76	62							
		LILIKS	4		·					
NATAZ CCORDINA LINKES TO	1E 45	38. 6	9. 350 59	; -48	-41	-40				
EFFCSLPE	81	154	177	147	178	138				
WEISHTED	€2	310	1785	296	378	2 " 8				
NCCE NO. 45	TOTAL	LINKS	20							
X.Y.Z COGRDINA		451 6		ı						
LINKEC TO	4.7	5.9	6.0	27	65	- • 1	-53	-43	-40	-:9
	-4 E	-32 213	-26 122	-27 211	-54	-37 211	+60 125	-64 191	-61 188	-59 183
EXPCSUPE	116	242	224	233	311	250	321	225	311	65
	250	2149 243	246 450	212	10	424	1300	1920	378 3120	184
#119F1EU	258	243	456	46 E	3150	251	3220	432	3120	132
		LINKS	9							
W.Y.Z CODACINA LINKED TO	1 E 64	74, 8	5. 330 71	55	-66	-61	-56	-68	-54	
EXPESUAE	53	• 7	19	37	137	344	211	325	297	
wE IG+TED	54	4.6	20	380	138	690	5150	652	2980	
NOCE NO. 71	1014	LIAKS	5							
X.Y.Z CCCFCINA	15	86. 10	2. 300							
FINKET TO	26	73	75	64	-65	-66				
	160 101	67 126	#5 #6	32 336	91 92	96 970				
NODE NO. 79 X.Y.Z CCORCINA		. LINKS 57. 16	10	1						
LINKEC TO	81	67	77	80	+5	53	6 €	-62	-69	-61
	169	74	140	91	345	276		300	94	2+3
WFIGHTED	190	22508	14100	94400	103F66	27700	300	703	41900	122000

Case 6 - Area 2, Route 2, Sensor Set 1.

Table A.9. Case 6 - Node Linkage for Route

	lable A.s.	Case 0	- 11000	Etimogo .	• • • • • • • • • • • • • • • • • • • •	
FRCM	EASTING NO	RTHING	TO	PENALTY	EASTING	NORTHING
			28	1	3610	9660
35	2770	10500	19	77	4100	9100
28	361C	9660		66	4240	10080
19	4100	9100	31	18	5290	10640
31	4240	10080	36	160	4730	10430
36	5296	106+0	34	54	5500	11270
34	473C	10430	46	105	6340	10710
46	55 C C	11270	38	36	5500	10150
38	6348	10710	32	56	5010	9100
32	5500	10150	-21	34	5439	8190
-21	5010	9100	11	10	4450	8470
11	543D	8190	12	56	4170	9240
12	4450	8470	22		2980	11060
22	4170	5240	42	51	2280	10360
42	2580	11060	33	64 55	2070	11410
33	2886	10360	-45		2630	12320
-45	2076	1141G	56	2	3260	11550
56	2630	12320	50	29	3470	10640
50	3261	11550	37	46		9870
37	3470	10640	30	5	2560	5030
30	2560	5e70	15	2	2580	7630
15	2560	9030	9	7	4870	7980
. 9	4870	7630	10	2	4100	9240
10	4100	79EC	-23	67	3120	
-23	3120	9240	-2	62	4240	7280
-2	4246	7280	7	1	5290	7630
7	5290	7630	-13	36	3190	8400
-13	3190	6400	-24	216	5580	9240
-24	2280	9248	-1	118	3190	7280
-1	3190	7280	ε	252	2840	7630
ė	2840	7630	52	44	2770	11760
52	2770	11760	57	154	3890	12390
52 57	3890	12390	-62	â	2840	12090
-62	2840	13090	70	166	2210	14600
70	2210	140C0	81	ê8	2560	14510
61	2560	14510	-76	236	2910	14420
-76	2910	14420	-71	<b>492</b>	2700	13720
-71	2700	13720	-52	40	4660	11830
-52	•668	11830	45	6.5	5150	11270
45	5158	11270	65	10	7150	13230
	7180	13236	71	23	8 C 2 0	14140
65	eC20	14140	79	86	6790	14560
71	£790	14560	66	1	9840	13510
79	248	13510	€1	€ 8	10260	12670
46	10260	12670	67	1	928G	
61	9280	13720	-58	2	9840	12880
67	984C	12880	69	91	10690	13860
-58		13860	62	Ş	19680	
69	10890	12610	68	5è	11590	
62	10680	13860	76	41	13610	
68	11590	14420	84	246	10960	14980
76	10610	14460	54	<b>3</b> -		

Table A.1	0.	Case 6	5 - No	de Li	inkage	<b>:</b>				
NOCE NO. 3		LLINKS								
LINKEC TO	33	11. 5	50	57	50	28	-42	-45		
EXPOSURE	100	66	77	69	4	0	141	103		
METCHLED	202	174	156	140	10	1	284	208		
		LLINKS	7							
X+Y+Z COORDI: LI4MED TO	55	19	31	15	37	30	-23			
EXPOSURE	134	76	121	137	66	47	195			
WEIGHTED	135	77	2 4 4	276	134	96	392			
			_							
		LLINKS								
PAYAZ CCORDI	. 22	12	31	-24	-21	-23	-13			
EXPOSURE	116	43	32	260	89	48	49			
METGHTED	234	66	66	522	90	98	100			
NCDE NO. 3	1 TOTA	LLINKS	. A							
K+Y+Z CGORDI		22	37	36	-26	- 4 9	-41	-21		
EMPOSURE	100	62	45	35 8	308	204	267	58		
WF IG - TEC	202	126	92	16	305	410	416	59		
		L LIAKS								
X+Y+Z FOOPDII Linkee to						47	- 12	- 10	- 4 4	- 4 1
LINKED TO	32 -27	.26	4.5	46	36	• •	-35	-39	-41	-43
EXPOSUPE	154	69	160	118	181	166	272	201	205	100
E /P' SURE	250	231	•••		•••	•••		•	•••	• • •
WEIGHTED	316	100	322	238	1820	1670	213	404	412	1810
MEIG-TED	502	464								
1055 15 1		LLINKS	7							
NOTE NO. 3										
	3.2	45	46	-41	-26	-40	-27			
LINKES TO Exposure	32 111	45 123	46 26	-41 268	-26 304	-40 223	-27 25e			
EXPOSURE WEIGHTED	111	123 248	26 54	268	304	223	576			
EXPOSURE WEIGHTED NOJE NO. 40	111 112 101A	123 248 L LINKS	26 54 9	228 268	304	223	576			
EXPOSURE WEIGHTEC MODE NO. 46 X+Y+Z CCCFCIF	111 112 101A	123 248 L LINKS 50+ 5	26 54 9	228 268	304	223	576	-41	-12	
EXPOSURE WEIGHTEC MODE NO. 46 X+Y+Z CCCFCIF	111 112 S TOTAL	123 248 L LINKS 50+ 5	26 54 9 1. 320	228 268	304 610	223 448 -39 122	235 236	-41 174	-12 154	
EXPOSURE WEIGHTED MODE NO. 46 X.Y.Z CCCFCII LINKED TO	111 112 5 TOTAL ATE 45	123 248 L LINKS 50, 5	26 54 9 1: 320 38	268 538	304 618 -53	223	238 239 -52			
EXPOSURE WEIGHTED  NOJE NO. 44 X.Y.Z CCCFCIF LINNED TO EXPOSURE WEIGHTED	111 112 5 TOTAL 5 TOTAL 45 100 202	123 248 L LINKS 50, 5 47 136 1370	26 54 9 1. 320 33 104 105	268 538 -43	304 610 -53 141	223 448 -39 122	235 235 -52 169	174	154	
EXPOSURE WEIGHTED  NODE NO. 46 N.Y.Z COCPCIP LINKEC TO EXPOSURE WEIGHTED  NODE NO. 36	111 112 5 TOTAL 65 100 202 5 TOT4	123 248 L LINKS 504 136 1370 L LINKS	26 54 9 10 320 38 104 105	268 538 -43	304 610 -53 141	223 448 -39 122	235 235 -52 169	174	154	
EXPOSURE WEIGHTED  NODE NO. 46 X+Y+Z CCCFCIF LINKEC TS EXPCSURE WEIGHTED  NCCE NO. 36 X+Y+Z CCGOCIF	111 112 5 TOTAL 65 100 202 5 TOT4	123 248 L LINKS 504 136 1370 L LINKS	26 54 9 10 320 38 104 105	268 538 -43	304 610 -53 141	223 448 -39 122	235 235 -52 169	174	154	
EXPOSURE WEIGHTED  NODE NO. 46 N.Y.Z COCPCIP LINKEC TO EXPOSURE WEIGHTED  NODE NO. 36	111 112 5 TOTAL 45 100 202 5 TOTAL	123 248 L LINKS 50. 5 136 1370 L LINKS 62. 5	26 54 9 1. 320 35 104 105 3. 340 27 246	268 538 -43 143 1440	-53 141 1420	223 448 -39 122 123	23e 235 -52 109 220 -17 320	174 350 -27 237	154	
EXPOSURE WEIGHTED  NOJE NO. 44 X+Y+Z COCCECIT LINKED TO EXPCSURE WEIGHTED  NCCE NO. 34 X+Y+Z COGOOIT LINKED TO	111 112 5 TOTAL 45 100 202 5 TOTAL	123 248 LLINKS 50+ 3 136 1370 LLINKS 62+ 5	26 54 9 1. 320 33 104 105 3. 340 27	268 538 -43 143 1440	-53 141 1420	223 448 -39 122 123	23e 239 -52 109 220	174 350 -27	154	
EXPOSURE WEIGHTED  NOJE NO. 44 N-Y-Z COCPCIP LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 34 X+Y-Z COGPOIT LINKED TO EXPCSURE WEIGHTED  WEIGHTED	111 112 5 TOTAL AFE 100 202 5 TOTAL AFE 195 392	123 248 L LINKS 50. 47 136 1370 L LINKS 62. 5 17 36	26 54 9 1. 320 33 104 105 8 3. 340 27 246 494	268 538 -43 143 1440	-53 141 1420	223 448 -39 122 123	23e 235 -52 109 220 -17 320	174 350 -27 237	154	
EXPOSURE MEIGHTED  MODE NO. 46 N.Y.Z COCPCIT LINKET TO EXPOSURE MEIGHTED  NCCE NO. 36 X.Y.Z COGOT! LINKED TO EXPOSURE MEIGHTED  MCCE NO. 36 MEIGHTED  MCCE NO. 35 MEIGHTED	111 112 5 TOTAL 45 100 202 6 TOTAL 47 195 392	123 248 L LINKS 50. 47 136 1370 L LINKS 52. 52 17 36 L LINKS	26 54 9 1. 32C 33 104 105 3. 34C 27 246 494	268 538 -43 143 1440	-53 141 1420	223 448 -39 122 123	23e 235 -52 109 220 -17 320	174 350 -27 237	154	
EXPOSURE WEIGHTED  NODE NO. 46 NAY-2 CCCPCIT LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 XAY-2 CGOROIT LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 XAY-2 CGOROIT LINKED TO EXPCSURE WEIGHTED	111 112 5 TOTAL 45 130 202 5 TOTAL 47 195 392 2 TOTAL	123 248 L LINKS 50. 7 136 1370 L LINKS 62. 72 17 36 L LINKS	26 54 9 10 320 33 105 3, 340 27 246 494	-45 145 1440 -35 232 466	-53 141 1420	223 448 -39 122 123	23e 235 -52 109 220 -17 320	174 350 -27 237	154	
EXPOSURE MEIGHTED  MODE NO. 46 N.Y.Z COCPCIT LINKET TO EXPOSURE MEIGHTED  NCCE NO. 36 X.Y.Z COGOT! LINKED TO EXPOSURE MEIGHTED  MCCE NO. 36 MEIGHTED  MCCE NO. 35 MEIGHTED	111 112 5 TOTAL 45 100 202 6 TOTAL 47 195 392	123 248 L LINKS 50. 47 136 1370 L LINKS 52. 52 17 36 L LINKS	26 54 9 1. 32C 33 104 105 3. 34C 27 246 494	268 538 -41 143 1440 -39 232 466	-53 141 1420 -32 271 544	-39 122 123 -43 200 402	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  NOTE NO. 44 X-Y-Z COCPCIT LINKET TO EXPCSURE WEIGHTED  NCCE NO. 34 X-Y-Z COGPOIT LINKED TO EXPCSURE WEIGHTED  NCCE NC. 34 X-Y-Z COGPCIA LINKED TO LINKED TO LINKED TO	111 112 5 TOTAL 45 130 202 5 TOTAL 475 195 392 2 TOTAL	123 248 LLINKS 510 136 1370 LINKS 620 17 36 LLINKS 50 17	26 54 9 1. 320 3.04 105 3. 340 27 246 494 5. 330 -32	268 538 -43 143 1440 -35 232 466	-53 141 1420 -32 271 544	223 448 -39 122 123 -43 200 402	23e 239 -52 109 220 -17 320 321	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  NOJE NO. 4 X+Y+Z COCPCIP LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 3: X+Y+Z COGPOIT LINKED TO EXPCSURE WEIGHTED  NCCE NC. 3: X+Y+Z COGPCIA LINKEC TO EXPCSURE WEIGHTED	111 112 5 TOTAL 45 130 202 5 TOTA 47 195 2 TOTA 49 100	123 248 L LINKS 510 137 136 137 L LINKS 620 17 36 L LINKS 527 527 676	26 54 1. 320 35 104 105 3. 340 27 246 494 5. 330 -32 291 292	268 538 -41 143 1440 -39 232 466	-53 141 1420 -32 271 544	-39 122 123 -43 200 402	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE MEIGHTED  MODE NO. 44 X*Y**2 CCCPCII LINKED TO EXPCSURE MEIGHTED  NCCE NO. 36 X*Y**2 CCOPCII LINKED TO EXPCSURE MEIGHTED  NCCE NO. 35 X*Y**2 CCOPCII LINKED TO EXPCSURE MEIGHTED  NCCE NO25 MODE NO25	111 112 5 TOTAL 45 150 202 5 TOTAL 47 195 2 TOTAL 21 49 100	123 248 L LINKS 574 7 136 1370 L LINKS 624 2 17 36 L LINKS 554 2 327 676 L LINKS	26 54 9 1. 320 35 104 105 8 3. 340 27 246 494 5. 330 -32 291 292	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544	-39 122 123 -43 200 402	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  NODE NO. 46 N+Y+2 CCCFCII LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 36 X+Y+2 CCOPOII LINKED TO EXPCSURE WEIGHTED  NCCE NC. 3: X+Y+2 CCOPOII LINKED TO EXPCSURE WEIGHTED  NCCE NC. 3: X+Y+2 CCOPOII LINKED TO EXPCSURE WEIGHTED	111 112 5 TOTAL 45 150 202 5 TOTAL 47 195 2 TOTAL 21 49 100	123 248 LINKS 524 5 136 1370 LINKS 624 5 17 36 LINKS 527 676	26 54 9 1. 320 35 104 105 8 3. 340 27 246 494 5. 330 -32 291 292	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544	-39 122 123 -43 200 402	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  MODE NO. 44 X*Y***Z CCCFCII LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 X*Y**Z CCOFCII LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 X*Y**Z CCOFCII LINKED TO EXPCSURE WEIGHTED  NOCE NO21 X*Y**Z CCOFCII LINKED TO EXPOSURE WEIGHTED  NOCE NO21 X*Y**Z CCOFCII LINKED TO EXPOSURE	111 112 5 TOTAL 150 202 5 TOTAL 195 392 2 TOTAL 21 49 100	123 248 L LINKS 574 7 136 1370 L LINKS 624 2 17 36 L LINKS 554 2 327 676 L LINKS	26 54 9 1. 320 35 104 105 8 3. 340 27 246 494 5. 330 291 292 6 0. 330 22	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544 -35 196 374	-23 448 -39 122 123 -43 200 402 -21 27 56	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE MEIGHTEC  NOJE NO. 44 X-Y-Z COCPCIP LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 34 X-Y-Z COGPOIT LINKEC TO EXPCSURE WEIGHTED  NCCE NC. 32 LINKEC TO EXPCSURE WEIGHTED  NCCE NC. 32 X-Y-Z COOPCIP LINKEC TO EXPCSURE WEIGHTED  NCCE NC. 32 X-Y-Z COOPCIP LINKEC TO EXPCSURE WEIGHTED	111 112 5 TOTAL 45 100 202 5 TOTA 47 195 21 49 100 1 TOTAL 48 1 TOTAL 48 12 12 13 14 14 15 16 16 16 16 16 16 16 16 16 16 16 16 16	123 248 L LINKS 510 137 136 137 LINKS 620 12 17 36 LINKS 527 676 676 L LINKS	26 54 1. 32C 35 104 105 3. 34C 27 246 494 5. 330 -32 291 292 6. 330 22	-43 143 1440 -39 232 466	-53 141 1420 -32 271 544 -35 195 374	-39 122 123 -43 200 402	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE MEIGHTED  NOJE NO. 4 X.Y.Z. COCPCIT LINKET TO EXPCSURE WEIGHTED  NCCE NO. 3: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NCCE NO. 3: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NOCE NO2: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NOCE NO2: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED	111 112 5 TOTAL 45 120 202 5 TOTAL 155 392 2 TOTAL 49 100 1 TOTAL 156 159	123 248 LINKS 1370 LINKS 620 17 36 LINKS 527 576 676 LINKS 127 527 676 LINKS	26 54 1. 32C 35 104 105 3. 34C 27 246 494 5. 330 -32 291 292 6. 330 22 48 98	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544 -35 196 374	-23 448 -39 122 123 -43 200 402 -21 27 56	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  MODE NO. 44 X*Y***Z CCCFCII LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 X*Y**Z CCOFCII LINKED TO EXPCSURE WEIGHTED  NCCE NO. 36 X*Y**Z CCOFCII LINKED TO EXPCSURE WEIGHTED  NOCE NO2: X*Y**Z CCOFCII LINKED TO EXPOSURE WEIGHTED  NOCE NO2: X*Y**Z CCOFCII LINKED TO EXPOSURE WEIGHTED  NOCE NO2: X**X**Z CCOFCII LINKED TO EXPOSURE WEIGHTEC  NOCE NO. 1:	111 112 5 TOTAL 130 202 5 TOTAL 195 392 2 TOTAL 21 100 1 TOTAL 159 1 TOTAL	123 248 L LINKS 524 7 136 1370 L INKS 624 7 36 L LINKS 434 3 123 66 L LINKS	26 54 9 1. 32C 35 104 105 8 3. 340 27 246 494 5. 330 291 292 6 0. 330 26 98	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544 -35 196 374	-23 448 -39 122 123 -43 200 402 -21 27 56	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE MEIGHTED  NOJE NO. 4 X.Y.Z. COCPCIT LINKET TO EXPCSURE WEIGHTED  NCCE NO. 3: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NCCE NO. 3: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NOCE NO2: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED  NOCE NO2: X.Y.Z. COGPCIT LINKET TO EXPCSURE WEIGHTED	111 112 5 TOTAL 130 202 5 TOTAL 195 392 2 TOTAL 21 100 1 TOTAL 159 1 TOTAL	123 248 LINKS 1370 LINKS 620 17 36 LINKS 527 576 676 LINKS 127 527 676 LINKS	26 54 9 1. 32C 35 104 105 8 3. 340 27 246 494 5. 330 291 292 6 0. 330 26 98	-43 143 1440 -35 232 465	-53 141 1420 -32 271 544 -35 196 374	-23 448 -39 122 123 -43 200 402 -21 27 56	23e 235 -52 109 220 -37 32c 321	174 350 -27 237 476	154	
EXPOSURE MEIGHTED  MODE NO. 44 X-Y-Z CCCPCIT LINKET TO EXPCSURE MEIGHTED  NCCE NO. 36 X-Y-Z CCOPCIT LINKED TC EXPCSURE MEIGHTED  NCCE NO. 36 X-Y-Z CCOPCIT LINKED TO EXPCSURE MEIGHTED  NOCE NO2: X-Y-Z CCOPCIT LINKED TO EXPOSURE MEIGHTED  NOCE NO2: X-Y-Z CCOPCIT LINKED TO EXPCSURE MEIGHTEC  NOCE NC. 1: X-Y-Z CCCOCIT LINKED TO EXPCSURE	111 112 5 TOTAL 130 202 5 TOTAL 195 392 2 TOTAL 21 100 1 TOTAL 21 159 1 TOTAL 31 159 1 TOTAL 31 159 1 TOTAL 31 159 1 TOTAL 31 159 159 159 159 159 159 159 159 159 15	123 248 LINKS 514 7 136 1370 LINKS 624 2 17 36 LINKS 527 576 LINKS 434 2 237 676 LINKS 434 2 237 676 LINKS	26 54 9 1. 32C 35 104 105 8 3. 340 27 246 494 5. 330 291 292 6 0. 330 26 98 7 7. 3C3 21 76	-43 143 1440 -35 232 465 -26 287 576	-53 141 1420 -32 271 544 -35 196 374 -26 730 662	-23 448 -39 122 123 -43 200 402 -21 27 56	-52 149 220 -37 320 321 -43 149 300	174 350 -27 237 476	154	
EXPOSURE MEIGHTEC  NOJE NO. 44 X-Y-Z CCCFCII LINKET TO EXPCSURE WEIGHTED  NCCE NO. 34 X-Y-Z CCGGOTI LINKED TO EXPCSURE WEIGHTED  NCCE NC. 32 X-Y-Z CCGGOTI LINKED TO EXPCSURE WEIGHTEC  NCCE NC. 32 X-Y-Z CCGGOTI LINKED TO	111 112 5 TOTAL 45 120 202 5 TOTAL 155 392 2 TOTAL 21 49 100 1 TOTAL 156 159 1 TOTAL 156 159	123 248 LINKS 136 1370 LINKS 62. 27 17 36 LINKS 127 676 LINKS 123 645 123 65 127 676 128 128 129 129 129 129 129 129 129 129 129 129	26 54 1. 32C 35 104 105 3. 34C 27 246 494 5. 330 -32 291 292 6. 330 22 48 98	268 538 -43 143 1440 -39 232 466 -26 287 576	-53 141 1420 -32 271 544 -35 195 374	-23 448 -39 122 123 -43 200 402 -21 27 56	-17 120 -17 120 321 -43 145 300	174 350 -27 237 476	154	
EXPOSURE MEIGHTEC  NOJE NO. 4 X.Y-Z CCCCCIT LINKEC TO EXPCSURE WEIGHTEC  NCCE NO. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTED  NCCE NC. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 2: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 1: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 1: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC	111 112 5 TOTAL 120 202 5 TOTAL 155 392 2 TOTAL 21 49 100 1 TOTAL 156 159 1 TOTAL 156 159 1 TOTAL 156 159 1 TOTAL 156 159 1 TOTAL 156 157 158 158 158 158 158 158 158 158 158 158	123 248 L LINKS 1370 L INKS 62. 27 176 62. 27 176 62. 27 176 63. 27 676 L LINKS 125 648 125 648 126 137 137 137 137 137 137 137 137 137 137	26 54 1. 32C 35 104 105 3. 340 27 246 494 5. 330 -32 291 292 0. 330 22 48 98 7. 3C3 21 76 154	-43 143 1440 -35 232 465 -26 287 576	-53 141 1420 -32 271 544 -35 196 374 -26 730 662	-23 448 -39 122 123 -43 200 402 -21 27 56	-52 149 220 -37 320 321 -43 149 300	174 350 -27 237 476	154	
EXPOSURE MEIGHTED  MODE NO. 4 X-Y-Z CCCPCIT LINKET TO EXPCSURE MEIGHTED  NCCE NO. 36 X-Y-Z CCOPCIT LINKED TC EXPCSURE MEIGHTED  NCCE NO. 36 X-Y-Z CCOPCIT LINKED TC EXPCSURE MEIGHTED  NOCE NO2: X-Y-Z CCOPCIT LINKED TO EXPOSURE MEIGHTED  NOCE NO. 1: X-Y-Z CCCPCIT LINKED TO EXPCSURE MEIGHTED  NCCE NO. 1: X-Y-Z CCCPCIT LINKED TO EXPCSURE MEIGHTED  NCCE NO. 1:	111 112 5 TOTAL 130 202 5 TOTAL 195 392 2 TOTAL 215 159 1 TOTAL 159 1 TOTAL 15	123 248 L ST 47 136 1370 L INKS 5 42 127 576 K 227 676 K 3 123 66 K 43 123 67 K 5 123 66	26 54 9 1. 32C 35 104 105 8 3. 340 27 246 494 5. 330 291 292 6 0. 330 26 98 7 7. 3C3 21 76 154	-43 143 1440 -35 232 465 -26 287 576	-53 141 1420 -32 271 544 -35 196 374 -26 730 662	-23 448 -39 122 123 -43 200 402 -21 27 56	-52 149 220 -37 320 321 -43 149 300	174 350 -27 237 476	154	
EXPOSURE MEIGHTEC  NOJE NO. 4 X.Y-Z CCCCCIT LINKEC TO EXPCSURE WEIGHTEC  NCCE NO. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTED  NCCE NC. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 3: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 2: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 1: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC  NCCE NC. 1: X.Y-Z CCGOOLI LINKEC TO EXPCSURE WEIGHTEC	111 112 5 TOTAL 130 202 5 TOTAL 195 392 2 TOTAL 215 159 1 TOTAL 159 1 TOTAL 15	123 248 L STARS 5 1370 L STARS 5 62 127 36 L STARS 5 108 STARS 1 237 676 L STARS 1 238 L L STARS 1 258 L L STARS 1 258 L L STARS 1	26 54 1. 32C 35 104 105 3. 340 27 246 494 5. 330 -32 291 292 0. 330 22 48 98 7. 3C3 21 76 154	-43 143 1440 -35 232 465 -26 287 576	-53 141 1420 -32 271 544 -35 196 374 -26 730 662	-23 448 -39 122 123 -43 200 402 -21 27 56	-52 149 220 -37 320 321 -43 149 300	174 350 -27 237 476	154	
EXPOSURE WEIGHTED  NOJE NO. 44 X+Y+Z COCFCIT LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 34 X+Y+Z COOPCIT LINKEC TO EXPCSURE WEIGHTED  NCCE NO. 21 X+Y+Z COOPCIT LINKEC TO EXPCSURE WEIGHTED  NOCE NO21 LINKEC TO EXPOSURE WEIGHTEC  NOGE NO. 11 X+Y+Z COCRCIT LINKEC TO EXPOSURE WEIGHTEC  NOGE NO. 11 X+Y+Z COCRCIT LINKEC TO EXPCSURE WEIGHTEC  NOGE NO. 11 X+Y+Z COCRCIT	111 112 5 TOTAL 12C 2C2 5 TOTA 12C 2C2 5 TOTA 12C 2C2 12T 125 12C 2C2 12T 12T 12T 12T 12T 12T 12T 12T 12T 12	123 248 LINKS 136 137 LINKS 62. 12 17 36 LINKS 52 17 67 67 67 67 67 67 67 67 67 67 67 67 67	26 54 1. 32C 35 104 105 3. 34C 27 246 494 5. 330 -32 291 292 66 98 77 3C3 21 76 154	268 538 -43 143 1440 -39 232 466 -26 287 576	-53 141 1420 -32 271 544 -35 196 374 -26 130 662	-23 448 -39 122 123 -43 200 402 -21 27 56	-52 149 220 -37 320 321 -43 149 300	174 350 -27 237 476	154	

Table A.10. (cont'd.	(cont'd.)
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Table A. IV.	100110	<b>u</b> .,							
NCDE NC. 22 TO	TAL LINKS								
STAZICADOS SAVAK		32. 300							
LINKED TO 15		21	37	30	•	1		42	33
LINKED TO 45		-26 -1	-2! -32	-13 -12	-27 -10	-40	-41	-24	- 2
EXPOSURE 11		134	78	70	52	-35 68	-3 144	-42 50	-43 49
EXPOSURE 11:		330	117	123	297	216	219	176	76
EXPOSURE 27	3 228	136	267	248	240	182	189	105	173
WEIGHTED 222		135	79	142	106	122	290	51	100
WEIGHTED 220		662	236	246	256	434	440	354	154
WEIGHTED 27	458	276	536	245	241	36 £	28.0	212	1740
NCDE NC. 42 TO	TAL LINKS	s e							
X.Y.Z CCCSDINATE		58. 300							
LINKED TO 50	37	52	33	-42	-45	-4 G	-48		
EXPOSURE 100		73	31	153	132	188	58		
MEIGHTED 201	2 68	74	64	306	266	376	198		
NCDE NC. 33 TO	TAL LINKS	3							
X.Y.Z CGGREINATE	4,	4ª • 300				,			
LINKED TO 3		-45							
E>PCSURE 100		96							
WEIGHTED 10:	1 155	99							
NCDE KC45 TO	TAL LINKS	. 3							
NOTOZ CCCPCINATE		63. 350							
LINKEC TO 5		-42							
EXPOSURE 36		194							
WEIGHTED 74	2	398							
NCDE NO. 56 TO	TAL LINKS								
X.Y.Z CCORDINATE	5 •	76. 300							
LINKED TO 5		-62	-59						
EXPCSURE 10	3 28	160	98						
WEIGHTEG 202	2 9	322	199						
NCCE NO. 50 TO1	TAL LINKS	5							
X.Y.Z COORCINATE									
LINKEC TO SE		57	-48	-40					
EXPOSURE 131	22	581	151	192					
MEIGHTEC 202	? 46	118	304	193					
NOCE +C. 37 TOT	AL LINES	•							
MAYAZ COCREINATE		52. 300							
LINKED TO 30	-40	-41	-48						
E.POSERE O		1 25	110						
JEIGHTED Z	534	392	555						
408E NC. 36 TOT	AL LINKS	3							
MAYOZ CCORCINATE		41. 300							
LINKED TO 15		-23							
EXPOSURE 0		3.6							
METCHASE S	456	13							
400E NO. 15 TOT	46 61445	14							
NOVOZ COCPEINATE									
LINKED TO 8		9	-23	-13	-24	-16	-3	- 1	-26
LINKEC TO -2		-40	-41						
EXPOSURE 155		. 76	132 173	130	208	261	512	138	257
EXPOSURE 48 WEIGHTED 312		176 7	266	262	418	524	426	278	258
WEIGHTED 98		354	342	•••		•••	•••		
			-						
	AL FINKS	3							
X+T+Z COCRDINATE	•1•	5+ 290							
LINKED TO 7 E>POSUPE 100		-2 120							
#E15HTE0 101		242							
	TEL LINKS								
MAYAZ COGNOINATE	, 30.	14. 300	-2	-13	-1	-23	-26	-3	-16
LIMEE TO -11		-24	-2¢	-27	•		- 20	•	
EYPOSUFE 6		87	119	121	172	66	267	500	209
CXPOSUFE 23	1 2:3	135	237	235					
ME IGHTED 6		176	240	244	346	67	536	405	450
MEIGHTED 23	2 234	272	230	480					
NCGE 4023 TO	TAL LIAKS	3 12							
F.Y.Z COGROINATE		32. 310							
LINKED TO	6 45	-24	-13	-16	-24	-3	-1	-40	-42
LIAMED TO -4								207	
EXPOSURE 150 EXPOSURE 190		220	124	276	287	221	133	207	134
utighted :0:		442	250	554	288	444	268	416	135
WEIGHTED 46									

Table A.10. (cont	t'd.)							
(00	,							
NODE NO2 TOTAL LI	NKS 2							
X.Y.Z CCORDINATE 32.								
	-1							
	36							
WEIGHTED 1 4	74							
NCDE NC. 7 TOTAL LI								
NODE NO. 7 TOTAL LIP	NKS 13							
FINATE TO SI	2 13	3	27	-10	-12	- 8	-20	-26
	-1 -13	•	• '		- 16		- 2 0	
<del>-</del>	ee 273	62	242	313	309	282	290	261
	57 17				•••			
	R9 274	63	486	314	310	283	562	524
WEIGHTED 534 19	56 36							
ACDE NO13 TOTAL LIF								
HAYAZ COORCINATE 174								
LINKED TO 8 -1	-	-3						
EXPOSURE 140 24 WEIGHTED 282 49		171 344						
#110H1CD 202	74 216	344						
NODE NO24 TOTAL LIM	NKS 6		•					
A.Y.Z CCORDINATE 4.								
LINKED TO 8 -1		-42	-1	-40				
EXPOSURE 82 28		127	50	163				
MEIGHTED 166 57	72 430	128	118	328				
•								
NOCE NO1 TOTAL LIN								
* + Y + Z COORCINATE 17+								
	• 3							
EXPOSURE 140 17								
BE 3 GHT ED 292 34	• •		•					
NOTE NO. 8 TOTAL LIN	NS 23							
A.Y.Z CCORCINATE 12.								
LINEC TO 21 1		5.2	45	27	47	- 3	-16	-26
LINVED TO -10 -1		-42	-27	-40	-41	-8	-48	-32
LINKEE TO -39 -4	3 -37							
EXPOSURE 102 24	19 81	21	96	259	166	274	274	262
EXPEGERE 252 25		132	273	199	199	239	118	251
EXPOSURE 173 16								
WEIGHTEG 103 25		44	194	260	1690	550	275	566
WEIGHTED 253 25		133	548	• 0 0	•00	240	238	584
WEIGHTED 348 170	3620							
NCCE NO. 52 TOTAL LIN								
X+Y+2 COCRDINATE 11+								
	-42	-48	-62	-40	-59	-41	-52	-71
LINKED TO -64 -6			• • •			180		1/1
	51 139	118	114	176	107	159	83	163
EXFOSUPE 201 26 WEIGHTED 156 18		238	230	177	216	160	160	1640
WFIGHTED 2020 270		. 30		• • •				
5. 1525 Ittl	•							
NCDE NO. 57 TOTAL LIN	KS 6							
	77. 330							
LINEC TO EC -	9 -48	-52	-64	-65				
EMPCSUPE 101 10	00 75	48	209	¢				
WEIGHTED 204 20	2 152	49	2100	5				
NGGE NC62 TOTAL LIN								
N.Y.Z COCRDINATE 12.								
	71 -59 79 165							
E P C SURE 82 27 WE I G P T E D 166 28								
# ( ) dF   100 20	.0 332							
NODE NO. 78 TOTAL LIN	AKS 3							
N.Y.Z COORDINATE 3.	100. 330							
LINKED TC 81 -7								
EXPOSUPE 87 21								
	1760							
NICE NO. 81 TOTAL LIN								
	113, 330	•						
LINKED TO 95		-76	-78	-74				
EYPOSURE 142 14		237	192	219 2200				
WEIGHTED 286 146	50 916	236	1930	2 2 4 4				
NODE NO76 TOTAL LIA	\KS 4							
	106. 340							
	78 -74	-71						
	2 279	245						

Table A.1	0 10	ant d	)							
Table A.	U. (C	ont u	• /							
N CE NO:	10141		12							
> Y - CC" FC			35.0							
LINKED T	71		72	€ 0	-74	-7 A	-59	- 04	-67	- 79
EIRPES TO	-44	-12	• •				• ,	•	٠.	
EXPESURE	167	163	1.16	F 7	231	202	12€	222	304	115
EXPOSURE	53	19					• • • •			
WE TOHTED	1:30	1540	1310	880	2320	2030	127	446	3656	1160
WFIGHTES	5.3	4 C								
	2 TOTAL		6							
A . Y . Z CCCRCI		364 6		_						
LINKED TO	45	E O	5.5	- 48	-41	-40				
EXFOSURE	A 1 E 2:	154	177 1780	147 296	188 378	138				
WEIGHTED	cs.	510	1/50	270	\$10	276				
NODE NO. 4	5 TOTAL	LINKS	21							
* + Y + Z COORDI		45. 6								
LINKED TO	47	5.9	60	21	27	65	-41	-53	-43	-40
LINKED TO	-39	-48	-32	-26	-27	-54	-37	-60	-64	-61
LINKED TO	-59									- •
EXPOSURE	188	213	122	32	211	0	211	129	191	188
EYPOSURE	183	118	242	224	233	311	250	321	225	311
EXPOSURE	6.5									
WEIGHTED	1890	2140	2 4 E	66	212 -		424	1300	1920	378
WEIGHTED	184	238	243	450	468	3120	251	3220	452	3120
ME IGHTED	132									
			_							
	5 TOTAL		9 330							
X+Y+Z EEGREI LINKED TO	64	74 + 8	71	5.5	-56	- <del>6</del> 1	-56	-68	-54	
EXPOSURE	53	47	15	37	137	344	211	325	297	
WEIGHTED	54	9.0	ž ć	300	138	690	2120	652	2986	
	-			• • •		• • •	• • • •	•••		
NODE NO. 7	1 TOTAL	LINKS	6							
X . Y . 2 COGADI		26. 10	2 . 300							
LINKED TO	80	73	75	64	-65	-66				
EXPESURE	100	67	<b>e</b> 5	32	91	96				
WEIGHTED	202	136	86	330	92	970				
				330	92	970				
NODE NO. 7	5 TOTAL	LIKKS	9	330	92	970				
NCDE NC. 7 N+Y+Z COORDI	S TOTAL NATE	, LINKS 97+ 10	9 300		-		- 02	-45	- 01	
ACDE AC. 7 *+Y+Z COORDI LIRKED TO	S TOTAL NATE 67	LIKKS 97 • 10	9 8• 300 80	89	53	66	- 82 300	-69	-81 243	
NCDE NC. 7 *+Y+Z COORDI LINKED TO EXPOSURE	5 TOTAL NATE 67 74	LIKKS 97+ 10 77 140	9 8• 300 80 91	89 345	53 276	66 0	300	94	243	
ACDE AC. 7 *+Y+Z COORDI LIRKED TO	S TOTAL NATE 67	LIKKS 97 • 10	9 8• 300 80	89	53	66				
NCDE NC. 7 x.y.2 coordi linked to exposure weighted	5 TOTAL NATE 67 74	LIRKS 97+ 10 77 140 141	9 8• 300 80 91	89 345	53 276	66 0	300	94	243	
NCDE NC. 7 x.y.2 coordi linked to exposure weighted	S TOTAL NATE 67 74 75 € TOTAL NATE 1	LIRKS 97+ 10 77 140 141 LIRKS	9 80 91 184 93, 250	89 345 346	53 276	66 0 1	300	94 190	243	
NCCE NC. 7 N-Y-Z COORDI LINKED TO EXPOSURE WEIGHTED NCCE NC. E X-Y-Z CCCCCI LINKED TO	5 TOTAL NATE 67 74 75 € TOTAL NATE 1	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5	9 80 91 184 9 25, 250	89 345 346	53 276 277	66 0 1	300 301 76	94 190 -72	243 488 -58	
NCCE NC. 7 N+Y+2 COOPDI LINKED TO EXPOSURE WEIGHTED NCCE NC. 6 X+Y+2 CCCCCI LINKED TO EXPOSURE	9 TOTAL NATE 67 74 75 € TOTAL NATE 1 67 77	LIAKS 97+ 10 77 140 141 LIAKS 12+ 5	9 80 91 184 9 77 166	89 345 346 63	53 276 277 277 62 103	66 0 1 69 102	300 301 76 131	94 190 -72 150	243 488 -58 164	
NCCE NC. 7 N-Y-Z COORDI LINKED TO EXPOSURE WEIGHTED NCCE NC. E X-Y-Z CCCCCI LINKED TO	5 TOTAL NATE 67 74 75 € TOTAL NATE 1	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5	9 80 91 184 9 25, 250	89 345 346	53 276 277	66 0 1	300 301 76	94 190 -72	243 488 -58	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRET LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 € TOTAL NATE 1 67 77	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5 61 23 68	9 80 91 184 95, 250 77 166 167	89 345 346 63	53 276 277 277 62 103	66 0 1 69 102	300 301 76 131	94 190 -72 150	243 488 -58 164	
NCCE NC. 7  K+Y+2 COORDI LINKED TO EXPOSURE WEIGHTED  NCCE NC. 6  X+Y+2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  NODE NC. 6  NODE NC. 6	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5 61 23 68 LIRKS	9 80 80 91 184 9 77 166 167	89 345 346 63	53 276 277 277 62 103	66 0 1 69 102	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LIAKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X** ACCERCI **NODE AC. 6  **X** ACCERCI **** ACCERCI **** ACCERCI **** ACCERCI **** ACCERCI	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156	LIRKS 97+10 77 140 141 LIRKS 12+5 61 23 68 LIRKS	9 80 91 184 9 73. 250 77 166 167	89 345 346	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
NCCE NC. 7  K+Y+2 COORDI LINKED TO EXPOSURE WEIGHTED  NCCE NC. 6  X+Y+2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  NODE NC. 6  NODE NC. 6	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5 61 23 68 LIRKS	9 80 80 91 184 9 77 166 167	89 345 346 63	53 276 277 62 103 208	66 0 1 69 102	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  RODE AC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62	LIRKS 97+ 10 77 140 141 LIRKS 12+ 5 61 23 68 LIRKS 18+ 5	9 80 91 184 9 25. 250 77 166 167	89 345 346	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  **AOPOSURE WEIGHTED  **EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191	LIAKS 97. 10 77 140 141 LIAKS 12. 5 61 23 68 LIAKS 18. 5 6 140 282	9 80 91 184 93. 250 77 166 167 61. 250 51 37 76	89 345 346 63 116 234	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y**Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y**Z CCCCCI LINKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y**Z CCCCCI LINKED TO EXPOSURE LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y**Z CCCCCI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL	LIAKS 97. 100 141 LIAKS 12. 5 68 LIAKS 18. 5 140 282 LIAKS	9 80 91 184 95, 250 77 166 167	89 345 346 63 116 234	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y***Z COORDI LIAKED TO EXPOSURE WEIGHTED  NODE AC. 6  **X***Z CCCRCI LINKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X***Z CCCRCI LINKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X***Z CCCRCI LINKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X***Z CCCRDI **NODE AC. 6  **X***Z CCCRDI	9 TOTAL NATE 67 78 75 € TOTAL NATE 1 67 7156 1 TOTAL 1,47E 1 62 190 191 7 TOTAL NATE 1	LINKS 97. 10 77 140 141 LINKS 12. 5 61 23 140 141 15 53 140 282 LINKS 18. 5 60 60 60 60 60 60 60 60 60 60 60 60 60	9 80 91 184 9 77 166 167 61. 250 51 37 76	89 345 346	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **X*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **X*** Z CCCRCI LINKED TO	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63	LIAKS 97. 10 77 140 141 LIAKS 12. 5 61 23 6 61 140 282 LIAKS 26. 77	9 80 91 184 93, 250 77 166 167 61, 250 51 37 76 596, 290 -72	89 345 346	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
NCCE NC. 7  **Y**Z COORDI LINKED TO EXPOSURE WEIGHTED  NCCE NC. 6  **Y**Z CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  **Y**Z CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X*Y**Z CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X*Y**Z CCCCCI LINKED TO EXPOSURE	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 41	LINKS 97. 100 141 LINKS 12. 5 68 LINKS 140 282 LINKS 0. 7 76	9 80 91 184 93, 250 77 166 167 61, 250 51 37 76 5	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **X*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **X*** Z CCCRCI LINKED TO	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63	LIAKS 97. 10 77 140 141 LIAKS 12. 5 61 23 6 61 140 282 LIAKS 20. 77	9 80 91 184 93, 250 77 166 167 61, 250 51 37 76 596, 290 -72	89 345 346	53 276 277 62 103 208	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  ***POSURE UINKED TO EXPOSURE WEIGHTED  ***********************************	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 61 89	LINKS 97. 10 77 140 141 LINKS 12. 5 61 23 64 140 282 LINKS 140 282 77 76 77	9 80 91 184 93, 250 77 166 167 61, 250 51 37 76 290 -72	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
NCCE NC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NCDE NC. 6  **Y** Z CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  **Y** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X**Y** Z CCCRDI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X**Y** Z CCCRDI LINKED TO EXPOSURE WEIGHTED  NODE NC5	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 91 89	LINKS 97. 100 141 LINKS 12. 5 68 LINKS 140 282 LINKS 04. 77 76 77 LINKS	9 80 91 184 93, 250 77 166 167 6 11, 250 51 37 76 5 290 -72	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y** Z COCRCI LINKED TO EXPOSURE WEIGHTED  ***POSURE UINKED TO EXPOSURE WEIGHTED  ***********************************	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 91 89	LINKS 97. 100 141 LINKS 12. 5 68 LINKS 140 282 LINKS 04. 77 76 77 LINKS	9 80 91 184 93, 250 77 166 167 6 11, 250 51 37 76 5 290 -72	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  X-Y-2 COORDI LIAKED TO EXPOSURE WEIGHTED  NODE AC. 6  X-Y-2 COCCRCI LINKED TO EXPOSURE WEIGHTED  AODE AC. 6  X-Y-2 CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  X-Y-2 CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  X-Y-2 CCCRDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  X-Y-2 CCCRDI LINKED TO EXPOSURE WEIGHTED  NODE AC5  X-Y-2 CCORDI	9 TOTAL NATE 67 75 € TOTAL NATE 1 67 7156 1 TOTAL 1ATE 1 62 190 191 7 TOTAL AATE 1 88 € TOTAL NATE 1	LINKS 97. 10 77 140 141 12. 5 61 23 140 141 18. 5 68 LINKS 18. 5 3 140 282 . LINKS 977 76 777 LINKS 12. 6	9 80 91 184 9 77 166 167 61. 250 51 37 76 5 5 96. 290 -72 100	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 102 103 -51 55	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCROI LINKED TO EXPOSURE WEIGHTED  NODE AC5  **Y*** Z COGROI LINKED TO  **Y*** Z COGROI LINKED TO	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 61 80 8 TOTAL NATE 1 63	LIAKS 97. 10 141 LIAKS 12. 5 140 282 LIAKS 140 282 LIAKS 17. 76 77 LIAKS 12. 62	9 80 91 184 93. 250 77 166 167 61. 250 51 37 76 290 -72 100	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  **Y*** Z COGROI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 61 8 TOTAL NATE 1 63 190 382	LIAKS 97. 10 77 140 141 LIAKS 12. 5 61 23 66 LIAKS 18. 5 140 282 LIAKS 17 76 77 LIAKS 12. 62 179 180	9 80 91 184 23. 250 77 166 167 6 167 6 107 76 51 250 250 27 27 100 101	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 102 103 -51 55 112	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LIAKED TO EXPOSURE WEIGHTED  **NOTE** X COCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRDI LIAKED TO EXPOSURE DEIGHTED  **NODE AC. 6  **X*** Z CCCRDI LIAKED TO EXPOSURE LIAKED TO EXPOSURE LIAKED TO EXPOSURE WEIGHTED  **NODE AC5  **X*** Z CCGROI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **NODE AC. 6	9 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 7156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 41 84 8 TOTAL NATE 1 63 190 302	LINKS 97. 10 77 1.00 1.01 1.00 1.00 1.00 1.00 1	9 80 91 184 9 77 166 167 61. 250 51 37 76 50. 290 -72 100 101	89 345 346 63 116 234 67 0 1	53 276 277 62 103 208 -58 188 378	66 0 1 102 103 -51 55 112	300 301 76 131	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  X-Y-2 COORDI LIAKED TO EXPOSURE WEIGHTED  NODE AC. 6  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  ADDE NC. 6  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NO5  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NO6  X-Y-2 CCCCCI LINKED TO EXPOSURE WEIGHTED  NODE NC. 6  X-Y-2 CCCCCI	5 TOTAL NATE 67 75 6 TOTAL NATE 1 67 156 1 TOTAL 147E 1 63 191 7 TOTAL 84 8 TOTAL NATE 1 63 190 2 32 9 TOTAL NATE 1	LINKS 97. 10 77 140 141 LINKS 12. 5 61 3 3 140 282 . LINKS 00. 77 77 LINKS 02. 179 180 LINKS 27. 5	9 80 91 184 9 77 166 167 61. 250 51 37 76 55 250 100 100 101	89 345 346 63 116 234 67 01 1	53 276 277 62 103 208 -58 188 378	66 0 1 69 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 5  **Y*** Z CCCROI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COGROI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 190 302 9 TOTAL NATE 1 76	LINKS 97. 10 77 140 141 LINKS 12. 5 61 23 6 LINKS 18. 5 140 202 LINKS 17 76 77 LINKS 12. 62 179 180 LINKS	9 80 91 184 93. 250 77 166 167 61. 250 51 37 76 250 101 6. 290 -72 100 101	89 345 346 63 116 234 67 0 1 1 7-69 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 1 69 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LIAKED TO EXPOSURE WEIGHTED  **NOTE AC. 6  **X*** Z CCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRDI LIAKED TO EXPOSURE EXPOSURE TO EXPOSURE	9 TOTAL NATE 67 74 75 6 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 41 63 41 63 190 302 9 TOTAL NATE 1 76	LINKS 97. 10 77 140 141 LINKS 12. 5 61 33 140 282 . LINKS 14. 62 179 180 LINKS 27. 5 8 114	9 80 91 184 9 77 166 167 4 51 51 37 76 51 51 37 76 100 101	89 345 346 . 63 116 234 67 01 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 5  **Y*** Z CCCROI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z COGROI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCREI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 190 302 9 TOTAL NATE 1 76	LINKS 97. 10 77 140 141 LINKS 12. 5 61 23 6 LINKS 18. 5 140 202 LINKS 17 76 77 LINKS 12. 62 179 180 LINKS	9 80 91 184 93. 250 77 166 167 61. 250 51 37 76 250 101 6. 290 -72 100 101	89 345 346 63 116 234 67 0 1 1 7-69 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 1 69 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 5  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCGRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCGRCI LINKED TO EXPOSURE WEIGHTED	5 TOTAL NATE 67 74 75 6 TOTAL NATE 1 67 77 156 1 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 190 382 9 TOTAL NATE 1 76 140 141	LINKS 97. 10 77 140 141 LINKS 12. 5 61 23 66 LINKS 18. 5 140 202 LINKS 12. 62 177 18. 62 179 180 LINKS 12. 68 114 115	9 80 91 184 23. 250 77 166 167 61. 250 51 37 76 250 101 6. 290 -72 100 101 8. 300 51 104 210	89 345 346 . 63 116 234 67 01 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRCI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **X*** Z CCCRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED  **NODE AC. 6  **Y** Z CCGRDI LIAKED TO EXPOSURE WEIGHTED	9 TOTAL NATE 67 74 75 6 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 61 190 302 9 TOTAL NATE 1 76 140 141 2 TOTAL	LINKS 97. 10 77 100 141 LINKS 12. 5 61 33 68 LINKS 18. 68 LINKS 140 282 LINKS 04. 77 77 LINKS 12. 62 179 180 LINKS 27. 68 114 115 LINKS	9 8 9 300 80 91 184 9 1 184 9 1 167 167 167 167 167 167 167 168 290 101 104 210 178 104 210 178 178 178 178 178 178 178 178 178 178	89 345 346 . 63 116 234 67 01 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	
ACCE AC. 7  **Y*** Z COORDI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 5  **Y*** Z CCCRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCGRCI LINKED TO EXPOSURE WEIGHTED  NODE AC. 6  **Y*** Z CCGRCI LINKED TO EXPOSURE WEIGHTED	9 TOTAL NATE 67 74 75 6 TOTAL NATE 1 62 190 191 7 TOTAL NATE 1 63 61 190 302 9 TOTAL NATE 1 76 140 141 2 TOTAL	LINKS 97. 10 77 100 141 LINKS 12. 5 61 33 68 LINKS 18. 68 LINKS 140 282 LINKS 04. 77 77 LINKS 12. 62 179 180 LINKS 27. 68 114 115 LINKS	9 8 9 300 80 91 184 9 1 184 9 1 167 167 167 167 167 167 167 168 290 101 104 210 178 104 210 178 178 178 178 178 178 178 178 178 178	89 345 346 . 63 116 234 67 01 1 769 132 266	53 276 277 62 103 208 -58 188 378 -38 0 2	66 0 1 102 103 -51 55 112	76 131 132	94 190 -72 150	243 488 -58 164	

# Table A.10. (cont'd.)

NCDE NC. 6	& TOTAL	LINKS	5				
X.Y.Z COORCI	NATE 1	37. 9	98. 30	0			
LINKED TO	78	76	-65	-73	-63		
EXPOSURE	223	40	346	319	215		
METCHLED	224	41	694	640	432		
NODE NO. T	6 TOTAL	LINKS	7				
X.Y.Z CCCRCI	NATE 1	23. 10	26. 30	C			
LINKED TO	84	77	78	-72	-80	-84	-65
EXPOSURE	245	119	175	69	267	289	222
	0.4.6			46666	20000	. 7000	111600

Case 7, Area 2, Route 1, Sensor Set 2.

Table A.11. Case 7 - Node Linkage for Route

FROM	EASTING	NORTHING	10	PERALTY	EASTING	NORTHING
3	3820	7280	9	2	4870	7630
9	4870	7630	13	1	4450	8470
13	4450	8470	7	50	5290	7630
7	5290	7630	-2	40	4240	7280
-2	4240	7280	11	101	4100	7580
11	4100	7980	31	17	2560	9870
31	2560	5870	37	1	3470	10640
37	3470	10640	50	41	3260	11550
50	3260	11550	56	22	2630	12320
F 6	2630	12320	-59	159	3610	12550
-59	3610	12950	-71	60	2700	13720
-71	2700	13720	-78	48	3540	14560
~78	3540	14560	-79	1	4590	15120
-19	4590	15120	87	89	5150	15470
£ 7	5150	15470	90	39	6060	15540
÷ O	6060	15540	83	5	6900	14980
P 3	6900	14980	80	36	7610	14700
6.0	781C	14700	79	34	8790	14560
79	6790	14560	81	160	9560	14770

Table A.1	2. (	Case 7	- Noc	de Li	nkage					
NODE NO.	3 TOTAL	LINKS	5							
HOPOCO Sever		26.	4+ 350							
LINKED TO	11		•	-2	-1					
EXPOSURE	75	107	Ç	148	166					
WE IGHTED	76	216	3	298	334					
NODE NO.		LIAKS	5							
X.Y.Z CCORCI		41.	9. 290							
LINKED TO	7	12	11	13	-2					
EXPOSURE	147	75	65	ō	137					
WEIGHTED	296	152	132	1	276					
		. LINKS	6							
X+Y+Z CCORDI			1. 290		_					
LINKED TO	11	19 79	23 87	12	7	-21				
EXPOSURE WEIGHTED	124 250	60	88	53 108	24 50	156 314				
45.10.150	230		•	100	-	3.7.				
NODE NO.	7 TOTAL	LINKS	•							
N.Y.Z COORCII	NATE	47.	9. 300							
LINKED TO	12	-10	-2	-12						
EXPOSURE	100	265	15	248						
MEIGHTED	202	532	4 C	498						
1005 No										
		LINKS	2 2 2 4 1 0							
LINKED TO	11	32. -1	4. 310							
EXPOSURE	100	96								
MEIGHTED	181	194								
	•••	• • •								
NODE NO. 1	TOTAL	LIRKS	21							
X+Y+Z COORDI	STAN	30. I	4. 300							
LINKED TO	19	23	8	12	. 18	28	22	32	31	-13
LINKED TO	-1	-21	-23	-26	-3	-18	-10	-12	-24	-20
LINKED TO	-27									
EXPOSURE	91	58	144	92	75	64	103	39	16	149
EXPOSURE EXPOSURE	155 163	134	91	218	176	175	265	271	148	270
WEIGHTED	92	99	290	186	96	65	208	40	17	300
WEIGHTED	312	270	92	219	354	352	540	544	298	542
MEIGHTED	368				•••		•••	• • •	. /•	346
	L TGTAL		6							
X.Y.Z CCORDI		4								
LINKER TO	34	18	2 &	37	-24	-23				
EXPCSUME					224					
	100	64	19	0	228	80				
MESCHIEC	101	130	19	1	228 458					
	101	130	40			80				
HOGE NO. 3	101 7 TOTAL	130 Links	40 7			80				
	101 7 TOTAL	130 Links	40			80	-42			
NOCE NO. 3'	101 7 TOTAL WATE	130 LIMKS 21. 5	40 7 2, 300 32 36	1 20 28	458 -40 259	80 81 -41 163	166			
HOGE NO. 3' F.Y.Z CGORDII LIRKED TO	101 7 TOTAL WATE 42	130 LINKS 21. 5	40 7 2. 300 32	20	458 -40	80 81 -41	_			
NOGE NO. 3' F.Y.Z CGORDII LIRKED TO EYPCSUPE WEIGHTED	101 7 TOTAL 42 100 202	130 LINKS 21. 5 50 48 41	40 7 2. 300 32 36 74	1 20 28	458 -40 259	80 81 -41 163	166			
NOCE NO. 3' F.Y.Z CGORDII LINKED TO EYPCSUPE MEIGHTED NCCE NO. 96	101 7 TOTAL 42 100 202 7 TOTAL	130 LINKS 21. 5 -0 -40 -1 LIAKS	40 7 2, 300 32 36 74	1 20 28	458 -40 259	80 81 -41 163	166			
NOGE NO. 3' F.Y.Z COORDII LINKED TO EYPCSUPE ME16MTED NCDE NO. 5 J.Y.Z COORDII	101 7 TOTAL WATE 42 100 202 9 TOTAL	130 LINKS 21. 5 -90 -40 -41 LIAKS 10. 6	40 7 2, 300 32 36 74 5, 300	1 26 28 58	-40 259 254	-41 163 368	166			
NOCE NO. 3' FOTOZ COORDII LIMED TO EPPCSUPE WEIGHTED NCCE KO. 9: FOTOZ COORDII LIMED TO	101 7 TOTAL WATE 42 100 202 9 TOTAL WATE 52	130 LINKS 21. 5 50 40 41 LIAKS 18. 6	40 7 32 36 74 5, 300	20 20 20 50	-40 255 256	-41 163 368	166			
NOGE NO. 3' F.Y.Z COORDII LINKED TO EYPCSUPE ME16MTED NCDE NO. 5 J.Y.Z COORDII	101 7 TOTAL VATE 42 100 202 8 TOTAL VATE 52	130 LINKS 21. 5 50 40 41 LIAKS 18. 6:	40 7 2, 300 32 36 74 5, 300	1 26 28 58	-40 259 254	-41 163 368	166			
NOCE NO. 3' P-Y-Z COORDII LINKED TO EPPCSUPE WEIGHTED NCCE NO. 90 J-Y-Z COORDII LINKED TO EVPOSURE	101 7 TOTAL WATE 42 100 202 9 TOTAL WATE 52	130 LINKS 21. 5 50 40 41 LIAKS 18. 6	40 7 2, 300 32 36 74 5, 300 56	20 20 20 50 50	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-Y-Z COORDII LINED TO EPPCSUPE WEIGHTED NCCE NO. 50 P-Y-Z COORDII LINKED TO ENPOSURE WEIGHTED NCCE NO. 50	101 7 TOTAL WATE 42 100 202 9 TOTAL WATE 57 100 202 5 TOTAL	130 LINKS 21. 5 40 41 LIAKS 10. 6 93 100	40 7 2. 300 32 36 74 6 5. 300 56 10 22	20 20 20 50 50	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' F-Y-2 COORDII LIRKED TO E-PCSUPE WE 16MYED NCCE NO. 9: F-Y-2 COORDII LIRKED TO E-POSUME WE 16MYED NCCE NO. 5: F-Y-2 COORDII NCCE NO. 5: F-Y-2 COORDII	101 7 TOTAL WATE 42 100 202 9 TOTAL WATE 57 100 202 5 TOTAL	130 LINKS 21. 5 50 40 41 LIAKS 10. 6: 93 100 LINKS 9. 7	40 7 2. 308 32 36 74 5. 300 5. 50 10 22	20 28 58 57 59	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 9' P-T-Z COORDII LINKED TO E-POSUME WEIGHTED NCCE NO. 5' N-T-Z COORDII LINKEC TO	101 7 TOTAL VATE 42 100 202 9 TOTAL VATE 57 100 202 6 TOTAL VATE 52	130 LINKS 21. 5 	40 7 2, 300 32 36 36 36 10 22 4, 300	20 28 28 28 37 37 39 57	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-Y-Z COORDII LIMED TO EPPCSUPE WEIGHTED NCCE NO. 5: J-Y-Z COORDII LINKED TO ENPOSURE WEIGHTED NCCE NO. 5: J-Y-Z COORDII LINKED TO EPPCSURE	101 7 TOTAL 9ATE 92 100 202 9 TOTAL 9ATE 52 100 202 5 TOTAL 9ATE 52 100	130 LINKS 21. 5 50 40 41 61 LINKS 10. 6 93 100 LINKS 9. 7 -62 21	40 7 2, 300 32 36 74 5, 300 56 10 22 4, 300 -45	20 20 20 20 50 57 50 59	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 9' P-T-Z COORDII LINKED TO E-POSUME WEIGHTED NCCE NO. 5' N-T-Z COORDII LINKEC TO	101 7 TOTAL VATE 42 100 202 9 TOTAL VATE 57 100 202 6 TOTAL VATE 52	130 LINKS 21. 5 	40 7 2, 300 32 36 36 36 10 22 4, 300	20 28 28 28 37 37 39 57	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 9: F-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: N-T-Z COORDII LINKEC TO E-PCSUPE WEIGHTED	101 7 TOTAL VATE 42 100 202 9 TOTAL VATE 57 100 202 5 TOTAL VATE 52 100 402	130 LINKS 21. 5 50 41 LIAKS 18. 6 42 93 100 LINKS 9. 7 -62 214 219	40 7 2, 300 32 36 74 6 30 4 6, 300 -45 165 332	20 20 20 20 50 57 50 59	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' F-Y-2 COORDII LIRKED TO EYPCSUPE MLIGHTED NCCE NO. 90 J-Y-2 COORDII LINKED TO ENPOSUNE MCIGHTED NCCE NO. 5 J-Y-2 COORDII LINKED TO EYPCSUNE MCIGHTED NCCE NO. 5 J-Y-2 COORDII LINKEC TO EYPCSUNE MEIGHTED NCCE NO5	101 7 TOTAL NATE 42 100 202 9 TOTAL 9ATE 57 100 202 6 TOTAL NATE 52 100 402	130 LINKS 21. 5 50 40 41 61 LINKS 10. 6 93 100 LINKS 9. 7 -62 21	7 300 32 36 74 55 300 22 4 4 300 -05 332 5	20 20 20 20 50 57 50 59	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 9: F-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: N-T-Z COORDII LINKEC TO E-PCSUPE WEIGHTED	101 7 TOTAL NATE 42 100 202 9 TOTAL 9ATE 57 100 202 6 TOTAL NATE 52 100 402	130 LINKS 21. 5 20 40 41 LIAKS 10. 6 42 93 100 LINKS 9. 7 -62 219 LIAKS	7 300 32 36 74 55 300 36 10 22 4 4 300 -05 332 5	20 20 20 20 50 57 50 59	-40 259 256 -48 219	-41 163 368	166			
NOCE NO. 3' P-T-2 COORDII LIRKED TO EYPCSUPE WE IGMTED NCCE NO. 91 N-T-2 COORDII LINKED TO ENPOSURE WE IGMTED NCCE NO. 50 N-T-2 COORDII LINKEC TO EYPCSUPE WE IGMTED NCCE NO50 N-T-2 CCOORDII NCCE NO50 N-T-2 CCOORDII	101 7 TOTAL VATE 92 100 202 9 TOTAL VATE 52 100 202 6 TOTAL VATE 52 100 202	130 LINKS 21. 9 10 40 41 LIAKS 10. 6 92 93 100 LINKS 9. 7 -62 219 LINKS 23. 8	40 7 2, 300 32 36 70 56 10 22 4 4 300 -05 165 332 5 9, 350	20 20 20 20 20 20 20 20 20 20 20 20 20 2	-40 255 256 -48 219 440	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO5: N-T-Z CCOORDII LINKEP TO	101 7 TOTAL VATE 42 100 202 9 TOTAL VATE 52 100 202 8 TOTAL VATE 52 100 202 9 TOTAL VATE 57	130 LINKS 21. 5 50 40 41 LIAKS 18. 6 92 93 100 LINKS 7. 7 -62 219 LIAKS 25. 8	40 7 2, 300 32 36 74 6 50 10 22 4, 300 -45 165 332 5 5 -62	20 28 28 28 28 28 28 29 29 29 29 29 29 29 29 29 29 29 29 29	-48 219 498	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO5: P-T-Z COORDII LINKED TO E-PCSUNE WEIGHTED NCCE NO5: P-T-Z CCOORDII LINKED TO E-PCSUPE WEIGHTED	101 7 TOTAL NATE 42 100 202 9 TOTAL NATE 52 100 202 6 TOTAL NATE 57 100 101	130 LINKS 21- 5 40 41 LINKS 18- 6 42 93 100 LINKS 9- 7 -62 219 219 LINKS 23- 6 107 256	40 7 2, 300 32 36 74 6 5, 300 86 10 22 4, 300 -45 165 332	20 28 28 28 37 37 39 39 -59 158 159	-40 255 256 -48 219 440	-41 163 368	166			
NOCE NO. 3' F-Y-Z COORDI' LINKED TO E-PCSUPE MLIGHTED  NCCE NO. 9 F-Y-Z COORDI' LINKED TO E-PCSUNE MCIGHTED  NCCE NO. 5 F-Y-Z COORDI' LINKET TO E-PCSUNE MEIGHTED  NCCE NO5 H-Y-Z CCORDI' LINKET TO E-PCSUPE MEIGHTED  NCCE NO5 H-Y-Z CCORDI' LINKET TO E-PCSUPE MEIGHTED  NCCE NO7	101 7 TOTAL VATE 42 100 202 9 TOTAL VATE 57 100 402 9 TOTAL VATE 57 100 101 1 TOTAL	130 LINKS 21. 5 20 40 41 LIAKS 10. 6 42 73 100 LINKS 7. 7 -42 219 LIAKS 23. 6 107 296 LINKS	7, 300 32, 36 74 5, 300 22 10, 22 4, 300 -05 165 332 5, 359 -62 163 332	20 28 28 28 37 37 39 39 -59 158 159	-40 255 256 -48 219 440	-41 163 368	166			
NOCE NO. 3' P-T-2 COORDII LIRKED TO E-PCSUPE WEIGHTED NCCE NO. 9: N-T-2 COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: N-T-2 COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO5: N-T-2 CCORDII LINKET TO E-PCSUPE WEIGHTED NCCE NO5: N-T-2 CCORDII LINKET TO E-POSUPE WEIGHTED NCCE NO7: N-T-2 CCORDII LINKET TO E-POSUPE WEIGHTED NCCE NC7: N-T-2 CCORDII	101 7 TOTAL VATE 92 100 202 9 TOTAL VATE 52 100 407E 52 100 407E 57 100 101 1 TOTAL WATE	130 LINKS 21. 5 10 40 41 LIAKS 10. 6 93 100 LINKS 9. 7 -62 219 LIAKS 23. 6 60 197 296 LINKS	40 7 2, 300 32 36 74 5, 300 56 10 22 4, 300 -45 165 332 5, 350 -62 165 332	20 28 28 28 37 39 37 39 39 158 159	-48 219 448 -71 39 88	-41 163 368	166			
NOCE NO. 3' P-T-Z COORDII LINKED TO EPPCSUPE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKED TO ENPOSURE WEIGHTED NCCE NO. 5: P-T-Z COORDII LINKEC TO EPPCSUPE WEIGHTED NCCE NO5: P-T-Z COORDII LINKEC TO EPPCSUPE WEIGHTED NCCE NO5: P-T-Z COORDII LINKEP TO EPPOSUPE WEIGHTED NCDE NC7: N-T-Z COORDII LINKED TO LINKED TO	101 7 TOTAL WATE 42 100 202 9 TOTAL WATE 52 100 202 6 TOTAL WATE 57 100 101 1 TOTAL WATE 70	130 LINKS 21- 5 40 41 LIAKS 18- 6 42 93 100 LINKS 9- 7 -62 219 LIAKS 23- 68 147 256 LINKS	40 7 2, 300 32 36 74 5, 300 56 10 22 4, 300 -45 165 332 5, 350 -62 163 350 -76	20 28 28 28 28 28 28 29 29 29 29 29 29 29 29 29 29 29 29 29	-48 219 -71 39 68	-41 163 368	166			
NOCE NO. 3' P-T-2 COORDII LIRKED TO E-PCSUPE WEIGHTED NCCE NO. 9: N-T-2 COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO. 5: N-T-2 COORDII LINKED TO E-PCSUPE WEIGHTED NCCE NO5: N-T-2 CCORDII LINKET TO E-PCSUPE WEIGHTED NCCE NO5: N-T-2 CCORDII LINKET TO E-POSUPE WEIGHTED NCCE NO7: N-T-2 CCORDII LINKET TO E-POSUPE WEIGHTED NCCE NC7: N-T-2 CCORDII	101 7 TOTAL VATE 92 100 202 9 TOTAL VATE 52 100 407E 52 100 407E 57 100 101 1 TOTAL WATE	130 LINKS 21. 5 10 40 41 LIAKS 10. 6 93 100 LINKS 9. 7 -62 219 LIAKS 23. 6 60 197 296 LINKS	40 7 2, 300 32 36 74 5, 300 56 10 22 4, 300 -45 165 332 5, 350 -62 165 332	20 28 28 28 37 39 37 39 39 158 159	-48 219 448 -71 39 88	-41 163 368	166			

			·						
NODE NO									
X.V.Z COORD!						_			
LINKEC TO	84		6.5	-74	-	-79			
EXPOSURE		70		195	112	•			
UE IGHTED	91	71	36	392	226	1			
NODE NO1									
X.Y.Z COORD!	ENATE	37. 11	6. 330						
LINKED TO	8 €	€7	72	75	84	74	76	-85	-74
EXPOSURE	100	6.6	90	90	80	62	44	93	96
MEICHLED	101	89	91	182	162	126	90	91	194
NODE NO. (	7 TOTAL	LINKS	6						
X.Y.Z COORCI	ENATE	45. 12	1. 320						
LINKED TO	86	45	90	-85	-88	-75			
EXPOSURE		40	3 6	119	105	96			
ue ighted	133	41	39	240	116	194			
NODE NO.		1 7445	6			•			
X.Y.Z COORE									
LINKEC TO		91	86	83	-88	-77			
EXPOSURE	132	103	77	8	121	96			ν.
HE IGHTED	133	104	156	9	244	194			
	3 TOTAL								
X.Y.Z CCORDI									
LINKED TO	91	73	6.6	85	80	-77		-75	
		98		63	35	138	53	97	
WEIGHTED	250	158	92	128	35	278	54	196	
	BO TOTAL								
X.Y.Z COORD									
LINKED TO	71	73	88	79	89	-81			
EXPOSURE		165		33	154	156			
WEIGHTED	202	212	26€	34	155	157			

NOCE NO. 79 TOTAL LINKS 10

X-Y-OZ CCORDINATE 97- 108- 200

LINKED TO 81 71 67 77 89 93 66

EXPOSURE 179 108 124 135 207 191 51

WEIGHTED 180 763C0 3750C 13600 62\*\*CC 19200 156CC

Table A.12. (cont'd.)

Case 8 - Area 2, Route 2, Sensor Set 2.

Table A.13. Case 8 - Node Linkage for Route

FROR	EASTING	NCRTHING	TO	PENALTY	EASTING	NORTHING
35	2770	10500	28	1	3610	9660
26	3610	9660	37	67	347G	10640
37	3470	10640	30	2	2560	9870
30	2560	5670	15	50	258	9030
15	2580	5030	9	7	4870	7630
5	4670	7630	12	1	4450	8470
12	4450	6470	7	50	5290	7630
7	5290	7630	-2	40	4240	7280
-2	4240	7280	10	101	4100	7980
10	4100	7580	31	37	4240	10080
31	4246	10080	36	52	5290	10640
36	5290	10640	46	119	5500	11270
46	550C	11270	34	9	4730	10430
3.4	473G	10430	32	156	5500	10150
32	5500	10150	-21	56	5010	5100
-21	5010	9100	11	34	5430	8190
11	5430	6190	21	19	5570	9170
21	557C	9170	19	110	4100	9100
19	410C	9100	-23	72	3120	9240
-23	3120	9240	22	10	4170	9240
2 <b>2</b>	4170	9240	42	34	2580	11060
42	2986	11060	33	64	2280	10360
33	2280	10360	56	34	2630	12320
56	2630	12320	50	29	3260	11550
50	3260	11550	57	59	389C	12390
57	3890	12390	-62	110	2840	13090
-62	2640	13090	70	2	2210	14000
70	5510	14380	81	1	2560	14910
21	256¢	14910	96	1	3610	15960
56	3610	15560	105	1	4660	17010
105	4660	17010	91	1	6650	15540
51	6620	15540	8.8	55	7670	15470
8 9	7670	15470	63	22	6500	14580
€3	6900	14980	60	46	7610	14700
60	7810	14700	79	34	8790	14560
79	6790	14560	66	52	9840	13510
66	9840	13510	76	144	10610	14428
76	10610	14420	<b>8</b> 4	191	13560	14980

		o 0	N.s.s	4_ 1 =	nkaan					
Table A.14	١.	Case 8	- NOC	ie Li	nkage					
NODE NO. 35	1014	LLINKS	8							
X+Y+Z COORDIN	47E	11. 5	300	37	50	28	-42	-45		
EXPOSUPE	100	66	77	69	•	D	193	154		
WEIGHTED	505	87	156	140	5	1	366	310		
		L LIAKS	7							
N.Y.Z COORCIN		23. 3	2. 300 31	15	37	**	- 22			
EXPOSUPE	22 134	76	121	137	66	30 47	-23 195			
MEIGHTED	135	77	244	276	67	96	392			
NEDE NO. 37	TOTA	LLINKS	,							
MICRODO Sevek	STA	21. 5	2. 300							
LINKEC TO Exposure	100	50 47	31 43	30	-40 256	193	-4 <i>f</i> 178			
WEIGHTED	202	46	0.0	ž	257	368	179			
NCDE AO. 30	TOTA	LINKS	•							
X.Y.Z COORDIN	ATE	8. 4								
LINKEC TO EXPOSURE	100	15 24	-24 214	-23 50						
WEIGHTED	101	50	430	51	•					
NCDE NC. 15	1014	LLINKS	22		•					
M. Y. Z CCORDIN			9. 310							
LINKEC TO	19	22	. 6	33	10	12	51	42	34	9
LINKED TO	-23 -40	-13 -41	-24	-18	-:	-1	-26	-21	-2	-42
EXPOSURE	61	73	114	60	59	41	54	37	28	6
EXPCSURE EXPOSURE	132	130 171	211	220	179	98	197	86	• 8	160
WEIGHTED	124	148	230	61	60	84	110	38	58	7
WEIGHTED WEIG⊁TED	133	262 17 <b>2</b>	424	442	360	198	396	174	96	161
NCDE NO. 9		LLINKS	5 9. 298							
FINKER TO	7	41.	10	12	-2					
EXPOSURE	147	75	65	0	137					
PEIGHTED	296	152	132	1	276					
		L LIAKS	6							
N.Y.Z CCORCIN		35+ 2		••	,	-21				
LINYEC TO EXPOSURE	10	19 79	22 81	11 53	24	156				
MEIGHTED	250	80	88	108	50	314				
NCCE NC. 7	TOTA	LLINAS	•							
X.Y.Z CCOPDIN			9. 366							
LINKEC TO EXPCSUFE	11	-10 265	-2 19	-12 248						
METGHTED	202	532	40	498						
NCGE NG2	TOTA	LLINKS	2							
X.Y.Z COORDIN	ATE	32.	4, 318							
LINKEC TO Exposure	100	-1 56								
ME ICHTED	101	154								
KODE NC. 10	TOTA	LLIAKS	18							
N.Y.Z CCORDIN		30. 1					_	_		
LINKEC TO	19 -26	- 3 22	-1 P	11 -10	-12	24	-12 -28	-1 -27	-21	-52
EXPOSURE	71	57	143	71	100	36	149	154	133	29
EXPOSURE VEIGHTED	216 72	173 56	172 288	266 184	267 202	144 37	300 300	178 310	260	70
PE I GHTED	217	348	346	534	536	290	534	358		
MCGE NC. 31	1074	LLIAKS	•							
X. Y.Z CCOADIN			4. "388							
LINFEC TO	34	5.5	17	36	-56	-40	-41	-21		
EXPOSURE VEIGHTED	234	79 160	39 80	25 52	249 250	205 206	20 <i>9</i>	65 66		
			••							
MODE NG. 36		47. 5	12 2, 100							
LINKED TO	32	3.	45	46	38	47	-32	-39	-41	-45
LINKED TO EXPOSURE	-27 158	-26 89	239	110	185	167	205	205	206	182
EXPOSURE	189	171			1944	1644	3844	284.5	414	1838
4616H160 4616H160	316	100 344	246	115	1860	1688	2068	5040	-14	1034

Table A.14	. (c	ont'd	.)							
NODE NO. 46		LINKS	10							
	45	47	36	34	-43	-53	- 3.6	-52	-41	-32
EXPOSURE	257	215	187	• 3	223	230	204	198	162	164
MEICHTED	516	2160	1880	8	2240	231	205 G	362	366	330
NGDE NO. 34	TOTAL	LINKS	6							
N.Y.Z CCORDIN		39, 4								
LINKED TO	32	45	-41	-26	-40	-27				
EXPOSURE	78	185	267	242	222	175				
WE IGHTED	158	186	268	486	446	352				
NODE NO. 32	TOTAL	LINKS	9							
X.Y.Z CCORDIN			5. 330							
LINKED TO	21	38	-27	-32	-26	-39	-51	-43 151	-41 167	
EXPCSURE WEIGHTED	49 100	183 1840	275 552	224 2250	227 456	150 1910	27 56	1520	336	
0010	•••									
NOCE NC21			6							
X.Y.Z CCORDIN		43. 3	.0. 333 19		-26	-27				
LINKEC TO Exposure	21 158	48	15	11 16	271	189				
MEIGHTED	318	98	40	34	272	380				
NOCE NO. 11		LINKS	7. 300	•						
LINKED TO	21	-12	-10	-20						
EXPOSURE	18	346	335	254						
MEIGHTED	19	694	680	510						
NODE NO. 21	TOT 4	LINKS	23							
X.Y.Z CCCRCIN										
LINKED TO	27	13	22	19	38	45	2	3	-27	~20
LINKED TO	-26	-12	-32	-10	- 35	-6	-15	-28	-37	-45
LINKED TO Exposure	-41 337	-40 321	-34 74	5+	214	183	76	69	278	354
EXPOSURE	254	321	233	309	212	288	300	312	550	193
EXPOSURE	190	175	195							
	3380	644	150	110	2150	184	154	140	558	710
WEIGHTED WEIGHTED	510 191	644 176	2340 1968	620	2136	578	3010	3130	2210	1940
ac tou.co										
NGDE NC. 19	707A	LINKS	•							
NCDE NC+ 19 N+V+Z CCORCIN	3 T A		10, 250							
H.V.Z CCORCIN	3 T A	30 · 3	10. 250 -23	-13						
X.Y.Z CCORCIN LINKED TO EXPOSURE	22 100	39. 1 -26 200	250 250 23 35	-13 39						
H.V.Z CCORCIN	3 T A	30 · 3	10. 250 -23	-13						
NOTOZ CORCIN LINKED TO EXPOSURE WEIGHTED NODE AC23	22 100 101 101	30. 1 -26 200 402 L LINKS	30+ 250 -23 35 72	-13 39 80						
NOTE AC23	22 100 101 TOT4	30. 1 -26 200 402 L LIRKS	30. 250 -23 35 72	-13 39 80						
NOTEZ CORCÍN LINKED TO EXPOSURE WEIGHTED NODE RO: -23 NOTEZ COORDIN LINKED TO	ATE 22 100 101 TOT4 ETE 22	30. 1 -26 200 402 LINKS 16. 1	30. 250 -23 35 72 32. 313	-13 39 80						
NOTE AC23	22 100 101 TOT4	30. 1 -26 200 402 L LIRKS	30. 250 -23 35 72	-13 39 80						
NOTE ACCORDING LINKED TO EXPOSURE WEIGHTED  NODE ACC23 X-Y-2 COORDING LINKED TO EXPOSURE WEIGHTED	ATE 22 100 101 TOTAL ETE 22 6 18	30 · 126 200 402 L LINKS 16 · 1 228 458	30+ 250 ~23 35 72 32+ 313 ~13 276	-13 39 80 -18 146						
NOTE AC23	ATE 22 100 101 TOT4 22 8 16 TOTA	30 • -26 200 402 L LINKS 16 • -24 228 458 L LINKS	250 250 250 250 250 250 250 250 250 250	-15 39 80 -18 146 294						
NOTE AC -23 X-Y-Z CCORCIN LINKE TO EXPOSURE WEIGHTED  NOTE AC -23 X-Y-Z CCORCIN LINKE TO EXPOSURE WEIGHTEC  NODE NO 22 X-Y-Z CCORCIN	ATE 22 100 101 TOTAL 22 8 18 TOTAL ATE	30 • -26 200 402 L LINKS 16 • -24 228 458 L LINKS	30+ 250 ~23 35 72 32+ 313 ~13 276	-15 39 80 -18 146 294	47	-26	-12	-27	-40	~*1
NOTE AC23 NOTE	ATE 22 100 101 TOT4 2 22 8 18 TOTA ATE 8 -24	30 - 26 200 402 L LINKS 16 - 24 228 458 L LINKS	30, 250 ~23 35 72 32, 313 ~13 137 276	-15 39 80 -18 146 294	47 -32	-26 -12 ·		-27 -3 <b>9</b>	-40 -3	-41 -42
NOTE AC23 X-Y-Z CCORCIN LINKEC TO EXPOSURE WEIGHTED  NOTE AC23 X-Y-Z CCORCIN LINKEC TO EXPOSURE WEIGHTEC  NOTE NO. 22 X-Y-Z CCORCIN LINKEC TO LINKEC TO LINKEC TO LINKEC TO	ATE 22 100 101 TOT44 ETE 22 8 18 TOTA ATE 8 -24 -43	30 - 26 200 402 LINKS 16 - 24 228 458 LINKS 21 - 22	250 250 250 250 250 250 250 250 250 250	-13 39 80 -18 146 294	-32	-12.	-16	-39	-3	~42
NOTE ACCORDING LINKE TO EXPOSURE WEIGHTED  MODE AC23 X.Y.2 COORDING LINKE TO EXPOSURE WEIGHTEC  NODE NO. 22 X.Y.2 COORDING LINKE TO LINKE	22 100 101 TOT4 LTE 22 8 18 TOTA ATE 8 -24 -43 96	30 - 20 200 - 402 L LINKS 16 - 24 228 - 458 L LINKS 21 - 42 - 20	250 250 250 250 250 250 250 250 250 250	-15 39 80 -18 146 294	-32 167	-12 ·	-1¢	-39 235	-3 216	-4 <i>2</i> 219
NOTE AC23 X-Y-Z CCORCIN LINKEC TO EXPOSURE WEIGHTED  NOTE AC23 X-Y-Z CCORCIN LINKEC TO EXPOSURE WEIGHTEC  NOTE NO. 22 X-Y-Z CCORCIN LINKEC TO LINKEC TO LINKEC TO LINKEC TO	22 100 101 TOT4 **TE 22 8 18 **TOTA ATE 8 -24 -96 175	30 - 26 200 402 LINKS 16 - 24 228 458 LINKS 21 - 22	250 250 250 250 250 250 250 250 250 250	-13 39 80 -18 146 294	-32	-12.	-16	-39	-3	~42
NOTE ACORCIN LINKE TO EXPOSURE WEIGHTED MODE ACO - 23 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTEC NODE NO 22 X-Y-Z CCORCIN LINKEC TO LINKEC TO LINKEC TO LINKEC TO LINKEC TO LINKEC TO LINKEC TO LINKEC TO LINKEC TO EXPOSURE EXPOSURE EXPOSURE EXPOSURE EXPOSURE EXPOSURE	22 100 101 TOT4 ETE 22 8 18 TOTA ATE 8 -24 -43 96 175 171	30. 2. 26 200 402 LINKS 16. 24 228 458 LINKS 21. 42 -20 33 300 34	250, 250 223 355 72 32, 310 -13 137 276 21 32, 300 33 -18 32 186 66	-15 39 80 -18 146 294 -1 187 91	-32 167 196 1680	-12 · 278 279 542	-10 113 271 228	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE AC23 NOTE	ATE 22 100 101 TOT4: ETE 22 8 18 TOTA: ATE 8 -24 -43 175 175 175 179 194 352	30. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.	250, 250 -23 35 72 -13 137 276 21 30 33 -18 32 186	-15 39 80 -18 146 294 -1 187 91	-32 167 196	-12° 278 279	-1¢	-39 235 163	-3 216 156	-42 219 156
NOTE ACORCIN LINKE TO EXPOSURE WEIGHTED MODE ACORCIN LINKE TO EXPOSURE WEIGHTEC NODE NO 22 X-Y-Z CCORCIN LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO LINKE TO EXPOSURE EXPOSURE EXPOSURE EXPOSURE EXPOSURE	22 100 101 TOT4 ETE 22 8 18 TOTA ATE 8 -24 -43 96 175 171	30. 2. 26 200 402 LINKS 16. 24 228 458 LINKS 21. 42 -20 33 300 34	250, 250 223 355 72 32, 310 -13 137 276 21 32, 300 33 -18 32 186 66	-15 39 80 -18 146 294 -1 187 91	-32 167 196 1680	-12 · 278 279 542	-10 113 271 228	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE AC23 NOTE AC. TO EXPOSURE WEIGHTED  NODE NO. 22 NOTE AC23 N	TOT4: LTE 22 8 18 TOTA: ATE 96 171 194 352 1720	3026 200 402 LINKS 1624 458 LINKS 2120 -20 33 300 502 LINKS	250, 250 -23 35 72 -13 137 276 21 32, 300 33 -18 32 186 66 37,	-15 39 80 -18 146 294 -1 187 -1 188	-32 167 196 1680	-12 · 278 279 542	-10 113 271 228	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE NO23 NOTE NOTE NOTE NOTE NOTE NOTE NOTE NOTE	ATE 22 100 101 TOT4  ETE 22 18 TOTA ATE 8 -24 -43 96 175 171 194 21720 TOTA	30. 26 200 402 LINKS 16. 228 458 LINKS 21. 22 -20 33 300 34 602 LINKS 14.	250, 250 -23 35 72 52, 310 -13 137 276 21 32, 300 33 -18 32 186 66 37,	-15 390 -18 1464 -1 187 -91 186	-32 167 196 1680 394	-12° 278 279 542 560	-10 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE AC23 X-Y-Z CORCIN LINKED TO EXPOSURE WEIGHTED  NOTE AC23 X-Y-Z CORCIN LINKED TO EXPOSURE WEIGHTED  NOTE NO- 22 X-Y-Z CORCIN LINKED TO LINKED TO LINKED TO LINKED TO LINKED TO EXPOSURE EXPOSURE EXPOSURE WEIGHTED WEIGHTED WEIGHTED  NOTE NO- 42 X-Y-Z CORCIN LINKED TO LINKED TO CORCIN LINKED TO LINKED TO CORCIN LINKED TO	ATE 22 100 101 TOT4 2 E 8 18 TOTA ATE 8 -243 96 175 171 194 352 0 TOTA ATE 5 C	30. 26 200 402 LINKS 16. 228 458 LINKS 21. 42 -20 33 300 34 602 LINKS 11. 42	250, 250 -23 -35 -72 -13 -13 -13 -276 -21 -32, 300 -33 -18 -32 -186 -66 -374	-15 39 80 -18 146 294 -45 -1 187 -91 188 184	-32 167 196 1680 394	-12 · 278 279 542 560	-16 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE NO23 NOTE NOTE NOTE NOTE NOTE NOTE NOTE NOTE	ATE 22 100 101 TOT4  ETE 22 18 TOTA ATE 8 -24 -43 96 175 171 194 21720 TOTA	30. 26 200 402 LINKS 16. 228 458 LINKS 21. 22 -20 33 300 34 602 LINKS 14.	250, 250 -23 35 72 52, 310 -13 137 276 21 32, 300 33 -18 32 186 66 37,	-15 390 -18 1464 -1 187 -91 186	-32 167 196 1680 394	-12° 278 279 542 560	-10 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE AC23 NOTE	ATE 22 100 101 TOTAL ETE 28 18 TOTAL ETE 29 6 175 179 4 352 1720 ATE CIGO 101	30 26 200 402 LINKS 16 24 458 LINKS 21 20 33 300 34 602 LINKS 73 74	250 - 250 - 23 - 35 - 72 - 13 - 13 - 13 - 13 - 13 - 18 - 32 - 18 - 32 - 18 - 66 - 37 - 31 - 6 - 66 - 37 - 31 - 6 - 66 - 37 - 31 - 6 - 66 - 37 - 31 - 6 - 66 - 37 - 31 - 6 - 66 - 37 - 31 - 6 - 6 - 6 - 37 - 31 - 6 - 6 - 6 - 6 - 6 - 6 - 6 - 6 - 6 -	-18 39 80 -18 146 294 -1 187 188 188	-32 167 196 168C 394	-12 · 278 279 542 560	-1C 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE NO CORCIN LINKE TO EXPOSURE WEIGHTED NOTE NO CORCIN LINKE TO EXPOSURE WEIGHTED	TTE 22 100 101 TOTAL ETE 28 18 TOTAL ATE 8 175 171 199 21720 TOTAL	3026 200 402 LINKS 1624 458 LINKS 2122 -20 33 300 34 602 LINKS 14273 74 LINKS	250 - 253 - 23 - 355 - 72 - 13 - 137 - 276 - 21 - 300 - 33 - 186 - 66 - 37 - 351 - 64 - 11	-15 39 80 -18 196 294 45 187 188 188	-32 167 196 168C 394	-12 · 278 279 542 560	-1C 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE NO23 NOTE NO23 NOTE NOTE NOTE NOTE NOTE NOTE NOTE NOTE	TOTAL  TO	3026 200 402 LINKS 1624 458 LINKS 2120 -20 33 300 502 LINKS 14273 74 LINKS	250, 250 -23 35 72 52, 310 -13 137 276 21 52, 300 33 -18 32 186 66 37, 50 64	-15 390 -18 1994 -1 1897 -1891 1894 -451 -4552	-32 167 196 168C 394	-12 · 278 279 542 560	-1C 113 271 228 272	-39 235 183 472	-3 216 156 217	-42 219 156 220
NOTE ACTOR TO LINKE TO	TTE 22 100 101 TOTAL ETE 28 18 TOTAL ATE 8 175 171 199 21720 TOTAL	3026 -260 -402 LINKS 1624 -246 -256 LINKS 2127 -20 -33 300 -34 -602 LINKS 74 -148 75 74 LINKS	250 - 253 - 23 - 355 - 72 - 13 - 137 - 276 - 21 - 300 - 33 - 186 - 66 - 37 - 351 - 64 - 11	-15 39 80 -18 146 294 45 -1 187 188 184	-32 167 196 168C 399	-12 · 278 279 279 542 560 -40 189 380 -45	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 314
NOTE AC23 NOTE AC33 NOTE	TOTAL  TOTAL  TOTAL  TOTAL  TOTAL  ATE  18  TOTAL  19  175  171  194  172  1720  TOTAL  TOTAL  ATE  50  101  TOTAL  ATE  50  101  TOTAL  ATE  50  101  TOTAL  ATE  50  101	3026 -260 -402 LINKS 1624 -246 -256 LINKS 2127 -20 -33 300 -34 -602 LINKS 74 -148 75 74 LINKS	250, 250 -23 35 72 52, 310 -13 137 276 21 52, 300 33 -18 32 186 66 37, 50 64	-15 390 -18 1994 -1 1897 -1891 1894 -451 -4552	-32 167 196 1680 399	-12 · 278 279 542 560 -40 169 360	-10 113 271 228 272 -48 166 167	-39 235 163 472 1898	-3 216 156 217 314	-42 219 156 220 314
NOTE AC23 NOTE AC33 NOTE	TTE 22 100 101 TOTAL 28 18 TOTAL 28 18 TOTAL 28 175 179 199 199 199 199 199 199 199 199 199	3026	250, 250 -23 35 72 -13 137 276 21 132, 300 33 -18 32 186 66 37, 35 64 48, 35 48, 35 48, 35	-15 39 80 -18 146 45 -1 187 -91 184 -42 -45 -12 -45 -45 -45 -45 -45 -45 -45 -45 -45 -45	-32 167 196 168C 394 -42 183 368	-12 · 278 279 279 542 560 -40 189 360 -45 233	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 319
NOTE AC23 NOTE AC33 NOTE	TOTAL  TOTAL  TOTAL  TOTAL  TOTAL  ATE  18  TOTAL  19  175  171  194  172  1720  TOTAL  TOTAL  ATE  50  101  TOTAL  ATE  50  101  TOTAL  ATE  50  101  TOTAL  ATE  50  101	3026 200 402 LINKS 1624 458 LINKS 2127 -20 33 300 34 602 LINKS 1473 74 LINKS 40	250 - 253 - 23 - 355 - 72 - 313 - 137 - 276 - 310 - 318 - 31	-15 39 80 -18 146 294 45 -1 187 188 184	-32 167 196 168C 399	-12 · 278 279 279 542 560 -40 189 380 -45	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 314
NOTE ACTOR IN LINKEC TO EXPOSURE WEIGHTED  NODE ACTOR IN EXPOSURE WEIGHTED  NODE NOTE WEIGHTED  NODE NOTE LINKEC TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WODE NOTE MODE NOTE LINKEC TO LINK	TOTAL	3026	250 - 250 - 23 - 35 - 72 - 13 137 276 - 21 132 - 18	-15 39 80 -18 146 45 -1 187 -91 184 -42 -45 -12 -45 -45 -45 -45 -45 -45 -45 -45 -45 -45	-32 167 196 168C 394 -42 183 368	-12 · 278 279 279 542 560 -40 189 360 -45 233	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 319
NOTE ACTOR IN LINKE TO EXPOSURE WEIGHTED  NODE AC23 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WODE NO22 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NODE NC. 33 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NODE NC. 33 X-Y-Z COORDIN LINKEC TO EXPOSURE EXPOSUR	TE 22 100 101 TOTAL 2 28 18 TOTAL 4 18 96 175 171 1992 1720 ATE 500 101 TOTAL 4 18 18 18 18 18 18 18 18 18 18 18 18 18	3026 200 a02 LINKS 1524 458 LINKS 2127 33 300 34 602 LINKS 77 74 LINKS 40 58 59 LINKS	250 - 250 - 23 - 35 - 72 - 13 - 137 - 13 - 137 - 186 - 374 - 11 - 40 - 300 - 76 - 33 - 34 - 8 - 33 - 34 - 8 - 35 - 35 - 35 - 35 - 35 - 35 - 35	-15 390 -1664 -129 4-1 181 184 -2012 -2012 -2012 -3012	-32 167 196 168C 394 -42 183 368	-12 · 278 279 279 542 560 -40 189 360 -45 233	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 319
NOTE NO23 NOTE NOTE NOTE NOTE NOTE NOTE NOTE NOTE	TTE 22 100 101 TOTAL 22 6 18 TOTAL 8 -24 -43 175 1794 252 1720 TOTAL ATE COLUMN 100 100 100 100 100 100 100 100 100 10	3026	250 - 250 - 23 - 35 - 72 - 13 - 13 - 13 - 13 - 13 - 18 - 32 - 18 - 32 - 18 - 32 - 18 - 32 - 18 - 33 - 34 - 34 - 35 - 35 - 35 - 35 - 35	-15 390 -18 1994 -1 187 91 189 -491 -201 -201 -7 59	-32 167 196 168C 394 -42 183 368 -42 249 250	-12 · 278 279 279 542 560 -40 189 360 -45 233	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 319
NOTE ACTOR IN LINKE TO EXPOSURE WEIGHTED  NODE AC23 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED WEIGHTED WEIGHTED WODE NO22 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NODE NC. 33 X-Y-Z COORDIN LINKEC TO EXPOSURE WEIGHTED  NODE NC. 33 X-Y-Z COORDIN LINKEC TO EXPOSURE EXPOSUR	TE 22 100 101 TOTAL 2 28 18 TOTAL 4 18 96 175 171 1992 1720 ATE 500 101 TOTAL 4 18 18 18 18 18 18 18 18 18 18 18 18 18	3026 200 a02 LINKS 1524 458 LINKS 2127 33 300 34 602 LINKS 77 74 LINKS 40 58 59 LINKS	250 - 250 - 23 - 35 - 72 - 13 - 137 - 13 - 137 - 186 - 374 - 11 - 40 - 300 - 76 - 33 - 34 - 8 - 33 - 34 - 8 - 35 - 35 - 35 - 35 - 35 - 35 - 35	-15 390 -1664 -129 4-1 181 184 -2012 -2012 -2012 -3012	-32 167 196 168C 394 -42 183 368	-12 · 278 279 279 542 560 -40 189 360 -45 233	-10 113 271 228 272 -48 166 167	-39 235 163 472 1848	-3 216 156 217 314	-42 219 156 220 319

14. (	cont'	d.	)
	14. (	14. (cont'	14. (cont'd.

NODE HO. 5	O TOTAL	LLINKS	•							
X.Y.Z COORDI	NATE	18. 6	5. 380							
LIRKEL TO	52	57	-4 A	-40						
EXPOSURE	100	£8	219	193						
MEIGHTED	202	59	440	388						
02,020		• ,		-						
NCGE 1.0. 5	7 TOTAL	L LINKS	6							
X.Y.Z COORDII		27, 7	7. 330							
LINKET TO	60	-59	-48	-52	-64	-62				
EXPOSUPE	172	160	143	122	191	54				
WEIGHTED	173	322	288	246	192	110				
				_						
			_							
AUPE AC67	2 TOTAL	LINKS	3							
X.Y.Z CCOPDII	NATE	12, 8	7. 350							
	70	-71	+59							
EXPOSURE	0	155	226							
WEIGHTED	2	156	454							
		LINKS	3							
X.Y.Z COORDII	NATE	3. 10	0. 330							
LINKEC TO	61	-71	-76							
EAPCSURE		195	86							
	_									
WE 1G+1ED	1	392	87							
NODE NO. 8	1074	LIAKS	6							
X.Y.Z COORDII		6. 11								
LISKED TO	95	65	96	-76	-78	-74				
EXPOSURE	57	49	Ō	147	97	127				
WEIGHTED	116	50	1	296	98	256				
NCDE NC. 90		LINKS	8							
X.Y.Z CCORDII		23. 12								
LINKED TO	82	102	95	185	93	-85	-92	-79		
EXPOSURE	63	149	54	0	190	54	146	24		
WEIGHTED	64	150	110	1	382	55	282	50		
NODE NO. 105			13							
TOUR TO IET	) IV'PL									
X.Y.Z CCORDII	MATE	38. 14	3. 330							
X.Y.Z CCORDII				85	82	95	91	-85	-88	-93
X.Y.Z CCORDII	87	86	90	85	82	95	91	-85	-88	-93
HAYAZ CCORDIÓ LINKED TO LINKED TO	87 -79	86 -95	90 -92							
X.Y.Z CCORDII	87	86	90 -92 28	85 13	82 59	95 53	91 0	-85 146	-88 137	-93 128
N.Y.Z CCORDIF LINKED TO LINKED TO EXPOSURE	97 -79 81	86 -95 62	90 -92 28							
N.Y.Z CORDIN LINKED TO LINKED TO EXPOSURE EXPOSURE	#7 -79 #1 #6	86 -95 62 121	90 -92 28 96	13	59	53	e	146	137	128
N.Y.Z CORDIN LINKED TO LINKED TO E>POSURE EYPOSURE WEIGHTED	87 -79 81 86 164	86 -95 62 121 126	90 -92 28 96 29							
N.Y.Z CORDIN LINKED TO LINKED TO EXPOSURE EXPOSURE	#7 -79 #1 #6	86 -95 62 121	90 -92 28 96	13	59	53	e	146	137	128
N.Y.Z CORDIN LINKED TO LINKED TO E>POSURE EYPOSURE WEIGHTED	87 -79 81 86 164	86 -95 62 121 126	90 -92 28 96 29	13	59	53	e	146	137	128
No Yoz CORDIN LINKED TO LINKED TO EXPOSURE EXPOSURE WEIGHTED WEIGHTED	87 -79 81 86 164 87	86 -95 62 121 126 244	90 -92 28 96 29	13	59	53	e	146	137	128
N. V. Z COORDIN LIMMED TO LIMMED TO E.>PCSURE EYPOSURE WEIGHTED MCIENC. SI	87 -79 81 86 164 87	86 -95 62 121 126 244	90 -92 28 96 29 194	13	59	53	e	146	137	128
X+V-Z CCORDIN LINNED TO LINNED TO E>PCSURE E+PCSURE WEIGHTED MCIENCE ST A+V-Z CCORDIN	87 -79 81 86 164 87 1 TOTAL	86 -95 62 121 126 244 LINKS 66, 12	90 -92 28 96 29 194	13 28	59 126	53 198	e	146	137	128
N. V. Z COORDIN LIMMED TO LIMMED TO E.>PCSURE EYPOSURE WEIGHTED MCIENC. SI	87 -79 81 86 164 87	86 -95 62 121 126 244	90 -92 28 96 29 194	13	59	53	e	146	137	128
No You COORDIN	97 -79 81 86 164 87 1 Total Wate 90	86 -95 62 121 126 244 LIRKS 66, 12	90 -92 28 96 29 194 2. 310	13 28	59 126 -87	53 196 -77	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE E+POSURE WEIGHTED ROCE NC. SI A+V-2 CORDIN LIANED TO E+PCSURE	97 -79 81 86 164 87 1 Total Wate 90 124	86 -95 62 121 126 244 LINKS 66 12	90 -92 28 96 29 194 6 310 85	13 28 88 58	59 128 -87 180	53 106 -77 73	e	146	137	128
No You COORDIN	97 -79 81 86 164 87 1 Total Wate 90	86 -95 62 121 126 244 LIRKS 66, 12	90 -92 28 96 29 194 2. 310	13 28	59 126 -87	53 196 -77	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>POSURE E+POSURE WEIGHTED MCCE NC. 5: A+V-Z CCORDIN LINNED TO E+POSURE WEIGHTED	97 -79 81 86 164 87 1 Total Wate 90 124	86 -95 62 121 126 244 LINKS 66 12	90 -92 28 96 29 194 6 310 85	13 28 88 58	59 128 -87 180	53 106 -77 73	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>POSURE E+POSURE WEIGHTED MCCE NC. 5! A+V-Z CCORDIN LINNED TO E+POSURE WEIGHTED	97 -79 81 86 164 87 1 TOTAL WATE 90 124 250	86 -95 62 121 126 244 LIAKS 66 12 83 87	90 -92 28 96 29 194 6 310 85 95 192	13 28 88 58	59 128 -87 180	53 106 -77 73	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED NCCE NC. SI A-V-2 CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 81 96 164 87 1 TOTAL MATE 90 124 250	86 -95 62 121 126 244 LIAKS 66 12 87 176	90 -92 28 96 29 194 2. 310 85 95 192	13 28 88 58	59 120 -87 100	53 106 -77 73	e	146	137	128
X+Y+Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NOCE NO. SI A+Y+Z CORDIN LINNED TO EXPOSURE WEIGHTED NOCE NO. BE X+Y+Z CORDIN	97 -79 81 96 164 87 1 TOTAL WATE 90 124 250 8 TOTAL	86 -95 62 121 126 244 LINKS 66 12 27 176	90 -92 28 96 29 194 6 5 95 192	13 28 88 58 59	59 126 -87 160 181	53 106 -77 73 148	e	146	137	128
X+V-Z CORROIN LINNED TO LINNED TO EXPOSURE EXPOSURE EXPOSURE WEIGHTED  NCCE NC. 5: A+V-Z CCORDIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 88 X+V-Z COORDIN LINNED TO	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 8 TOTAL WATE 80	86 -95 62 121 126 244 LIRKS 66 12 87 176 LIRKS 81 12	90 -92 28 96 29 194 6 5 195 192 1• 320	13 28 86 58 59	59 126 -87 180 181	53 106 -77 73 148	e	146	137	128
X+Y+Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NOCE NO. SI A+Y+Z CORDIN LINNED TO EXPOSURE WEIGHTED NOCE NO. BE X+Y+Z CORDIN	97 -79 81 96 164 87 1 TOTAL WATE 90 124 250 8 TOTAL	86 -95 62 121 126 244 LINKS 66 12 27 176	90 -92 28 96 29 194 6 5 95 192	13 28 88 58 59	59 126 -87 160 181	53 106 -77 73 148	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED NCCE NC. SI A+V-Z CORDIN LINNED TO CHPOSURE WEIGHTED NOCE NO. 88 X+V-Z CORDIN LINNED TO EXPOSURE	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 3 TOTAL WATE 80 29	86 -95 62 121 126 244 LINKS 66 17 27 176 LINKS 81 12 73	90 -92 28 96 29 194 6 5 95 192 6 1. 320 8	13 28 88 58 59 -81 139	59 126 -87 180 181	53 198 -77 73 148	e	146	137	128
X+V-Z CORROIN LINNED TO LINNED TO EXPOSURE EXPOSURE EXPOSURE WEIGHTED  NCCE NC. 5: A+V-Z CCORDIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 88 X+V-Z COORDIN LINNED TO	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 8 TOTAL WATE 80	86 -95 62 121 126 244 LIRKS 66 12 87 176 LIRKS 81 12	90 -92 28 96 29 194 6 5 195 192 1• 320	13 28 86 58 59	-87 126	53 106 -77 73 148	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED NCCE NC. SI A-V-Z CORDIN LINNED TO E>PCSURE WEIGHTED NODE NO. SE X-V-Z CORDIN LINNED TO EXPCSURE WEIGHTED	97 -79 81 66 169 87 1 TOTAL WATE 250 8 TOTAL WATE 29 60	86 -95 62 121 126 244 LINKS 66, 17 27 176 LINKS 61, 12 83 10 22	90 -92 28 96 29 194 2. 310 85 95 192 6 1. 320 29	13 28 88 58 59 -81 139	-87 126	53 198 -77 73 148	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED NCCE NC. SI A+V-Z COORDIN LINNED TO E>PCSURE WEIGHTED NOCE ND. 88 X+V-Z COORDIN LINNED TO EXPCSURE WEIGHTED	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 8 TOTAL WATE 80 29 68	86 -95 62 121 126 244 LIAKS 66, 17 83 87 176 LIAKS 61, 12 83 10 22	90 -92 28 96 29 194 2. 310 85 195 192 1. 320 116 117	13 28 88 58 59 -81 139	-87 126	53 198 -77 73 148	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED NCCE NC. SI A+V-Z COORDIN LINNED TO E>PCSURE WEIGHTED NOCE ND. 88 X+V-Z COORDIN LINNED TO EXPCSURE WEIGHTED	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 8 TOTAL WATE 80 29 68	86 -95 62 121 126 244 LIAKS 66, 17 83 87 176 LIAKS 61, 12 83 10 22	90 -92 28 96 29 194 2. 310 85 195 192 1. 320 116 117	13 28 88 58 59 -81 139	-87 126	53 198 -77 73 148	0 1	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE EXECUTED WEIGHTED ROCE NC. SI A-V-Z CORDIN LINED TO EXPOSURE WEIGHTED NODE NO. RE X-V-Z CORDIN LINED TO EXPOSURE WEIGHTED NODE NO. RE X-V-Z CORDIN LINED TO EXPOSURE WEIGHTED	97 -79 81 66 164 87 1 TOTAL WATE 90 124 250 8 TOTAL WATE 80 29 68	86 -95 62 121 126 244 LINKS 66: 12 27 17 LINKS 81: 12 73 10 22	90 -92 28 96 29 194 2. 310 85 95 192 1. 320 89 116 117	13 28 86 58 59 -81 139	-87 126	-77 73 148 -90 150	e	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. SI N-V-Z CORDIN LINNED TO EXPOSURE MEIGHTED NODE NO. 88 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 81 -66 164 167 1 TOTAL WATE 90 124 250 3 TOTAL WATE 20 3 TOTAL WATE 73	86 -95 62 121 126 244 LINKS 66, 12 21 17 176 LINKS 61, 12 83 10 22 LINKS	90 -92 28 96 29 194 2. 310 85 95 192 6 2. 320 116 117 7	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294	-77 73 148 -90 150	0 1	146	137	128
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X+V-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. SI N-V-Z CORDIN LINNED TO EXPOSURE MEIGHTED NODE NO. 88 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 81 -66 164 167 1 TOTAL WATE 90 124 250 3 TOTAL WATE 20 3 TOTAL WATE 73	86 -95 62 121 126 244 LINKS 66, 12 21 17 176 LINKS 61, 12 83 10 22 LINKS	90 -92 28 96 29 194 2. 310 85 95 192 6 2. 320 116 117 7	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294	-77 73 148 -90 150	0 1	146	137	128
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X+V-Z CORDIN LINNED TO LINNED TO E-PCSURE EVPOSURE WEIGHTED RCCE NC. SI A-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NOTE ND. 88 X-V-Z COORDIN LINNED TO EXPCSURE WEIGHTED NOTE NO. 83 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NOTE NO. 83 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NODE NC. 85	97 -79 61 66 164 87 1 TOTAL WATE 90 124 250 3 TOTAL WATE 73 124 250 7 TOTAL	86 -95 62 121 126 244 LINKS 66: 17 27 176 LINKS 61: 12 83 10 22 LINKS 70: 11 85 76 154	90 -92 28 96 29 194 2. 310 85 192 1. 220 116 117 7. 300 80 47 48	13 28 88 58 59 7 -81 139 140	-87 120 -87 180 181 -87 146 294	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. 5: A+V-Z CCORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-V-Z COORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 85 X-V-Z COORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 81 P6 164 87 1 TOTAL NATE 90 124 250 3 TOTAL NATE 73 125 250 7 TOTAL NATE	86 -95 62 121 126 244 LINKS 66: 12 27 176 LINKS 81: 12 73 10 22 LINKS 70: 11 85 76 154	90 -92 28 96 29 194 2. 310 85 192 1. 220 29 116 117 4. 300 80 47 48	13 28 88 58 59 -81 139 140	-87 128 -87 180 161 -87 146 294	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. 5: A+V-Z CCORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-V-Z COORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 85 X-V-Z COORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 81 P6 164 87 1 TOTAL NATE 90 124 250 3 TOTAL NATE 73 125 250 7 TOTAL NATE	86 -95 62 121 126 244 LINKS 66: 12 27 176 LINKS 81: 12 73 10 22 LINKS 70: 11 85 76 154	90 -92 28 96 29 194 2. 310 85 192 1. 220 29 116 117 4. 300 80 47 48	13 28 88 58 59 -81 139 140	-87 128 -87 180 161 -87 146 294	-77 73 148 -90 150		146	137	128
X+V-Z CORROIN LINNED TO LINNED TO EXPOSURE EXPOSURE EXPOSURE WEIGHTED  ROCE NC. SI A-V-Z CORROIN LINNED TO EXPOSURE WEIGHTED  ROCE NO. 88 X-V-Z CORROIN LINNED TO EXPOSURE WEIGHTED  ROCE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NC. 86 X-V-Z CORRIN LINNED TO	97 -79 -81 -64 -87 -1 TOTAL WATE -90 -8 TOTAL WATE -73 -124 -250 -7 TOTAL WATE -71	86 -95 62 121 126 244 LIAKS 66. 17 27 176 LIAKS 70. 11 85 76 154 LIAKS 33. 11	90 -92 -92 -96 -29 -194 -2. 310 -85 -95 -195 -195 -195 -195 -195 -195 -195	13 28 88 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E-PCSURE EVPOSURE WEIGHTED RCCE NC. SI A-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NOTE NO. 88 X-V-Z COORDIN LINNED TO EXPCSURE WEIGHTED NOTE NO. 83 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED	97 -79 61 P6 144 87 1 TOTAL WATE 90 124 250 3 TOTAL WATE 73 124 250 0 TOTAL WATE 71 124 250	86 -95 62 121 126 244 LINKS 66: 12 27 176 LINKS 61: 12 83 10 22 LINKS 70: 11 85 76 154	90 -92 28 96 29 194 2. 310 95 192 1. 220 1. 220 1. 300 80 47 48 5 300 80 47 48	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X+V-Z CORROIN LINNED TO LINNED TO EXPOSURE EXPOSURE EXPOSURE WEIGHTED  ROCE NC. SI A-V-Z CORROIN LINNED TO EXPOSURE WEIGHTED  ROCE NO. 88 X-V-Z CORROIN LINNED TO EXPOSURE WEIGHTED  ROCE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NO. 83 X-V-Z CORRIN LINNED TO EXPOSURE WEIGHTED  NODE NC. 86 X-V-Z CORRIN LINNED TO	97 -79 -81 -64 -87 -1 TOTAL WATE -90 -8 TOTAL WATE -73 -124 -250 -7 TOTAL WATE -71	86 -95 62 121 126 244 LIAKS 66. 17 27 176 LIAKS 70. 11 85 76 154 LIAKS 33. 11	90 -92 -92 -96 -29 -194 -2. 310 -85 -95 -195 -195 -195 -195 -195 -195 -195	13 28 88 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E-PCSURE EVPOSURE WEIGHTED RCCE NC. SI A-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NOTE NO. 88 X-V-Z COORDIN LINNED TO EXPCSURE WEIGHTED NOTE NO. 83 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED	97 -79 61 P6 144 87 1 TOTAL WATE 90 124 250 3 TOTAL WATE 73 124 250 0 TOTAL WATE 71 124 250	86 -95 62 121 126 244 LINKS 66: 12 27 176 LINKS 61: 12 83 10 22 LINKS 70: 11 85 76 154	90 -92 28 96 29 194 2. 310 95 192 1. 220 1. 220 1. 300 80 47 48 5 300 80 47 48	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X-Y-Z COORDIN LINNED TO LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED  RCCE NC. SI A-Y-Z CORDIN LINNED TO E>PCSURE MEIGHTED  ROCE NO. 88 X-Y-Z CORDIN LINNED TO EXPCSURE WEIGHTED  ROCE NO. 83 X-Y-Z CORDIN LINNED TO EXPCSURE WEIGHTED  NCDE NC. 80 X-Y-Z CORDIN LINNED TO EXPCSURE WEIGHTED  NCDE NC. 80 X-Y-Z COORDIN LINNED TO EXPCSURE WEIGHTED  NCDE NC. 80 X-Y-Z COORDIN LINNED TO E>PCSURE WEIGHTED	97 -79 -61 -64 -87 1 TOTAL WATE -90 -60 3 TOTAL WATE -124 -250 0 TOTAL WATE -73 -124 -250 0 TOTAL WATE -71 -100 -202	86 -95 62 121 126 244 LIAKS 66. 17 27 176 LIAKS 70. 11 85 76 154 LIAKS 83, 11 73 105 212	90 -92 -92 -96 -29 -194 -2. 310 -85 -95 -195 -195 -195 -195 -195 -195 -195	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED ACCE NC. SI A-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 61 66 166 187 1 TOTAL WATE 90 124 250 3 TOTAL WATE 73 124 250 0 TOTAL WATE 71 100 202	86 -95 62 121 126 244  LINKS 66: 17 87 176  LINKS 81: 12 83 10 154  LINKS 83: 11 73 105 212	90 -92 28 96 29 194 2. 310 95 192 1. 220 117 7 4. 300 80 47 48 0. 300 80 47 48	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X+V-Z CORDIN LINNED TO LINNED TO ENPOSURE ENPOSURE WEIGHTED NCCE NC. 5: A+V-Z CCORDIN LINNED TO ENPOSURE WEIGHTED NODE NO. 88 X-V-Z COORDIN LINNED TO ENPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO ENPOSURE WEIGHTED NCDE NC. 85 X-V-Z COORDIN WEIGHTED NCDE NC. 85 X-V-Z COORDIN WEIGHTED NCDE NC. 85 X-V-Z COORDIN WEIGHTED	97 -79 81 P6 164 87 1 TOTAL NATE 90 124 250 8 TOTAL NATE 73 124 90 1250 0 TOTAL NATE 71 100 202	86 -95 62 121 126 244 LINKS 66, 17 23 176 LINKS 61, 12 73 100 22 LINKS 83, 11 73 105 212	90 -92 28 96 29 194 2. 310 85 195 1. 320 89 1117 4. 300 80 48 0. 390 34	13 28 88 58 59 -81 139 140 90 54 114	-87 128 -87 160 161 -87 146 294 -77 161 324	-77 73 148 -90 150 151	-*79 97 196	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED ACCE NC. SI A-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 85 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 61 66 166 187 1 TOTAL WATE 90 124 250 3 TOTAL WATE 73 124 250 0 TOTAL WATE 71 100 202	86 -95 62 121 126 244  LINKS 66: 17 87 176  LINKS 81: 12 83 10 154  LINKS 83: 11 73 105 212	90 -92 28 96 29 194 2. 310 95 192 1. 220 117 7 4. 300 80 47 48 0. 300 80 47 48	13 28 86 58 59 -81 139 140	-87 126 -87 180 181 -87 146 294 -77 161 324	-77 73 148 -90 150		146	137	128
X-Y-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. SI A-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 87 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 -61 -64 -87 -1 TOTAL WATE -90 -125 -90 -107AL WATE -126 -250 -71 -100 -202 -71 -100 -202 -71 -71 -71 -71 -71 -71	86 -95 62 121 126 244  LIAKS 66. 17 83 176  LIAKS 70. 11 85 76 154  LIAKS 93. 11 73 105 212  LIAKS 97. 10	90 -92 -92 -96 -29 -194 -2. 310 -95 -195 -195 -195 -195 -195 -195 -195	13 28 88 58 59 -81 139 140 56 114	-87 146 294 -77 161 324 -81 166 157	-77 73 148 -90 150 151	-*75 97 196	146	137	128
X+V-Z CORDIN LINNED TO LINNED TO E>PCSURE EYPOSURE WEIGHTED RCCE NC. SI A-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED ROCE NO. 88 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED RODE NO. RI X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-V-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED RODE NC. 87 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED RODE NC. 75 X-V-Z CORDIN LINNED TO E-PCSURE WEIGHTED RODE NC. 75 X-V-Z CORDIN LINNED TO E-PCSURE	97 -79 61 66 166 187 1 TOTAL NATE 90 124 250 3 TOTAL NATE 71 100 202 0 TOTAL NATE 71 100 202	86 -95 62 121 126 244 LINKS 66: 12 27 176 LINKS 61: 12 83 100 22 LINKS 83: 11 73 105 212 LINKS 87: 10 67 124	90 -92 28 96 29 194 2. 310 85 195 1. 220 1. 220 1. 220 1. 300 80 47 48 5 300 77 8. 300 8. 73 34	13 28 86 58 59 -81 139 140 90 56 114	-87 126 181 -87 126 294 -77 161 324 -81 176 157	-77 73 148 -99 150 151	-279 97 196	146 149	137 138	128
X-Y-Z CORDIN LINNED TO LINNED TO EXPOSURE EXPOSURE WEIGHTED NCCE NC. SI A-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 88 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NODE NO. 83 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 86 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED NCDE NC. 87 X-Y-Z CORDIN LINNED TO EXPOSURE WEIGHTED	97 -79 -61 -64 -87 -1 TOTAL WATE -90 -125 -90 -107AL WATE -126 -250 -71 -100 -202 -71 -100 -202 -71 -71 -71 -71 -71 -71	86 -95 62 121 126 244  LIAKS 66. 17 83 176  LIAKS 70. 11 85 76 154  LIAKS 93. 11 73 105 212  LIAKS 97. 10	90 -92 -92 -96 -29 -194 -2. 310 -95 -195 -195 -195 -195 -195 -195 -195	13 28 88 58 59 -81 139 140 56 114	-87 146 294 -77 161 324 -81 166 157	-77 73 148 -90 150 151	-*75 97 196	146	137	128

## Table A.14. (cont'd.)

NODE NO. 6	F TOTAL		9	1					
LINKED TO	67	€1	77	63	62	69	76	-72	-58
EXPOSURE	127	100	160	174	234	157	143	238	289
MEIGHTED	256	202	161	350	470	158	144	239	560
NOTE NO. 7	5 TOTAL	LINKS	9						
X.Y.Z CCORCIO	ATE 1	23. 10	6. 300	1					
LINKEC TO	69	6.9	77	78	6.8	-72	-80	-84	-65
EXPOSURE	155	190	110	181	131	113	233	205	187
WEIGHTED	780	191	55500	54600	39600	79800	23400	61800	94000

#### APPENDIX B

#### FORTRAN PROGRAM FOR ROUTING MODEL

The program that has been developed as a result of this research is currently running on a CDC Cyber 7400 series machine. The programmed model has been tested on a ten kilometer area and was run for a 35 by 35 km area. The longest running feature of the model is the line of sight calculations. The model has 14 subroutines which are controlled by the main program and one subroutine. The relationship between the subroutines is shown in Figure B-1.

Within this appendix is a short discussion of the model. The basic purpose and operations of the various subroutines are given first. The arrays in COMMON and those that are not are defined. Also variables within COMMON are defined along with some which are used only in a single subroutine. With one exception, flow charts were not drawn for the model since the definition of the variables and the comments within the program itself should be sufficient. The logic of subroutine CLUST is not obvious, therefore a flow chart was drawn for this subroutine. Lastly, within this appendix is a listing of the Fortran computer code for the 10 by 10 km size model.

### Main Program

The main program is an executive routine that directs the operation of the model. Five subroutines are called by the main program. The initial call is to INDATA which is a short subroutine that reads the terrain data. After this call the main program groups this elevation

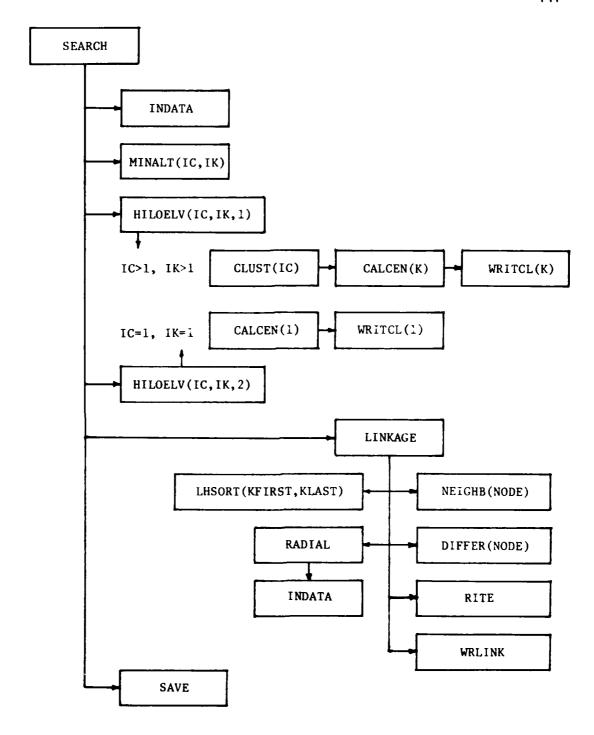


Figure B-1. Main Program and Subroutine Relationship.

data into elevation bands. Each sensor site's elevation is obtained from this data by finding the sensor's location within the elevation data array. A call is then made to the MINALT subroutine to determine both the maximum and minimum elevation groups within each elevation data array of 1 km square. Two calls are made to HILOELV subroutine; the first call is for processing the low elevation band and the second call is for the high elevation band. The next subroutine called is LINKAGE which is an executive subroutine that directs the routing process. If the results of route development are to be retained for further use, then SAVE can be called.

#### **INDATA**

This subroutine only reads the elevation data for the model. The terrain data is read in strips of 1 km wide and up to 50 km long. The data is stored into arrays of 15 by 15 data points and have a terrain interval of 70 meters between points. As each new strip of terrain is needed, a call is made to this subroutine.

#### MINALT

The minimum and maximum elevation data points in an array are found and stored in arrays in a packed format. The array ISET contains the row and column index of each low point and the array MSET contains the high points. The data is processed sequentially from the first terrain data array element such that if a new minimum or maximum is found, the pointers and counter are reset.

#### HILOELV

This subroutine is divided into two major parts. An IF test is performed on a call parameter ILO to determine whether the low

1

elevation (IC, —,ILO=1) or high elevation data (—,IK,ILO=2) is processed. The logic is the same for each part. A call is made to CLUST which identifies disjoint groups of elevation data. After finding the members of each cluster a call is made to CALCEN to calculate the cluster center. If there is only a single value in this cluster, CLUST is skipped and CALCEN is called directly. The values on these centers are then stored in LOWCEN or HICEN depending on which type of elevation data is being processed. After storing these values a return is made to the main program.

#### CLUST

Once the low or high data points are identified the cluster to which they belong is determined by the beginning and end of each data point string. The data points have been found sequentially; therefore, the breaks in adjacency of points define the cluster boundaries. Since the row and column indexes are stored by letting IVAL = (ROW \* 100) + COLUMN, subtracting two consecutive values will indicate whether they are adjacent. When all the members of a cluster are found, a call is made to CALCEN to calculate the centroid of the cluster.

#### **CALCEN**

This subroutine calculates the centroid of the cluster found in CLUST. The mean of row indexes  $(\vec{Y})$  and mean of column indexes  $(\vec{X})$  are the values for the center of the cluster. Since the indexes are integer values, the sum of the indices has a half added to allow for truncation of the decimal portion. An IF test is made on the calculated indexes for the center to ensure that they are within the array dimensions. For debug purposes several write statements in this subroutine can be set.

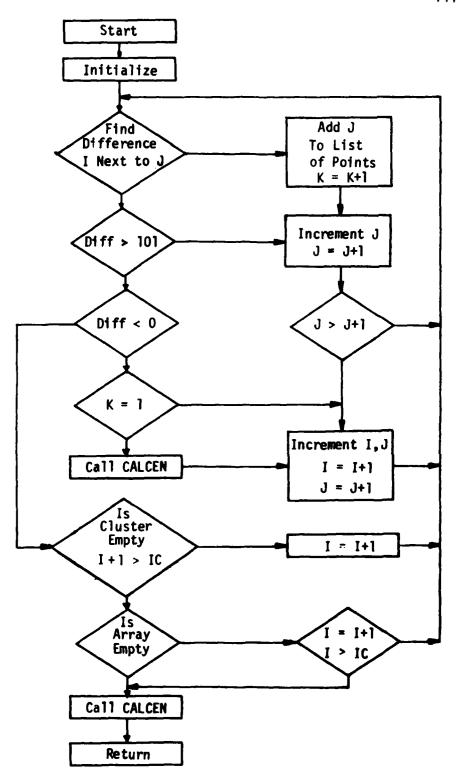


Figure B-2. Subroutine CLUST.

### WRITCL

To list the clusters and centers this subroutine can be called letting LWRIT  $\geq$  3. The low (or high) elevation cluster and pointers to the cluster members are listed. When this routine is called, LH is checked to decide whether high or low elevation values are to be printed.

#### LINKAGE

Once all the high and low elevation centers have been found, the main program calls this subroutine. The remaining portion of the model is directed by LINKAGE. The first subroutine it calls is LHSORT to sort the high and low lists of centers. Then subroutine RADIAL is called to determine the LOS between each node point and each sensor. RADIAL also calculates the first part of the penalty function.

The routine now processes each route node by finding all other node points which are within 1 km. These other nodes are the neighborhood of points that have possible links between them and the current node being evaluated. Two arrays, LINK and LINKTO, are used to store which nodes are in the neighborhood, the penalty value associated with the nodes and a beginning of the list for each node. The high nodes are identified by a minus sign. Having defined the neighborhoods and penalty values for each point in the neighborhood, the route node is selected. Control is then returned to the main program.

#### RADIAL

This subroutine is the most time consuming of the model. To determine visibility of two terrain points requires more effort than would seem to be necessary. The first problem is to locate where the two points are in the terrain data base. Along the vector connecting

these points a search is made for any terrain feature that would block the line of sight.

The subroutine first determines whether the sensor or the node is the westernmost point. If necessary the logic will swap the two points to set the node as the western point and the sensor as the eastern point. Having established the ends of the LOS vector, the tangent from the horizontal and the sine and cosine are calculated.

With those parameter values the routine begins the search along the vector. The vector is tested to locate its direction. Depending on whether it's between  $0^{\circ}$ - $45^{\circ}$ ,  $45^{\circ}$ - $135^{\circ}$ , or  $135^{\circ}$ - $180^{\circ}$  will give a heading of north, east or south respectively. The calculations used are given in section 4.3.

The routine finishes by listing the exposure values calculated for the number of sensors that can see each node. These values will then be used by DIFFER for those nodes which lie along the route corridor.

#### **LHSORT**

The initial point and the terminal point are added to the list of low elevation centers. The low elevation centers (nodes) are sorted into ascending order by row. This sorting is to ease the logic for the model. After the low centers are finished the high elevation centers are sorted in the same manner. Pointers KFIRST and KLAST are used to locate the initial and terminal nodes and are set after the sorting of LOWCEN. The lists of low and high nodes are written out as tables before returning to LINKAGE.

### NEIGHB

To define a neighborhood it was found that the normal visual search pattern is limited to 1 km. The nodes which lie within 1 km are considered

to be neighbors of the cur ent node. The resulting area is a 2 km square with the principle node in the center. Having sorted the arrays of centers, only 15 rows in either direction from the current row are searched for a neighbor. For any row that is searched, only those nodes which are within 15 columns on either side of the current node are retained as neighbors. When both the low and high centers that are in the neighborhood have been found, they are stored for use by subroutine DIFFER. The results can be listed by having LWRIT > 2.

#### DIFFER

For each neighborhood the distance from the current (primary) node is calculated and stored. The DIST array retains the distances for low centers in the first column and the high centers in the second column. The minimum and maximum distance and elevation are found while the distance between node points is calculated. Once these values are obtained they are sorted in ascending order by distance. A value of LWRIT > 2 will allow the printing of these results. The routine then completes the calculation of the exposure value for these nodes using the values stored by RADIAL.

#### RITE

This routine will write several of the large arrays to temporary storage if there are more values than the arrays can handle. These data are then read back into the program as needed on top of those values no longer needed.

### SAVE

This routine will save the route and linkage arrays for plotting.

A TAPE 7 is set up to store the data in a format for plotting the X-Y

coordinates of the nodes. The routine can be easily modified to write any data that should be retained.

### WRLINK

After the route has been found, this routine will list the linkage information used in constructing the route. Listed are the arrays, the pointers and nodes with their exposure values.

## Arrays in COMMON

IDATA(I,J,K)	This array contains terrain elevation values. It is a three dimensional array where the index K indicates the map sheets. The initial values are reassigned based on the equation given in section 4.2
LOWCEN(I,J,K)	The X, Y and Z coordinate of the low elevation nodes are stored in this array. Index I contains the Y value, J contains the X value, and K contains the Z value.
HICEN(I,J,K)	This array is just like LOWCEN except it contains the X, Y and Z coordinate of the high elevation nodes.
IPOINT(I)	This array is used throughout the model to store pointers.
ISET(I)	The row and column indexes of each cluster member are packed into this array. The first time used it contains low elevation points. The second time it contains the high elevation points.
MSET(I)	This array stores the high elevation cluster members for use by ISET.
CEROID(X,Y,Z)	As the centers for the low and high centers are being calculated CEROID is used to temporarily store them before placing them in either LOWCEN or HICEN.
ISITE(I,J,K)	The location of the sensors are stored in this array. Up to 10 sensors can be used as currently dimensioned.
INITIAL(I)	The location of the starting point for the route is entered into this array.
LAST(I)	The terminal point for the route is stored in this array.
LINK(I)	This array contains the pointers to the entries of LINKTO. The value in location I gives the beginning of the node list in LINKTO that is associated with node I of array FROM.

LINKTO(I,J,K)	This array has the node number of the nodes linked to node I of FROM. J is the exposure value of that node and K is the weighted exposure value.
FROM(I)	The route nodes are stored in order of occurence in this array. If I is the tenth entry then this node number is the tenth rode of the route.
TO(I,J)	The first entry I contains the node that is reached from the FROM(I) node. The value stored in J is the weighted exposure for the node traveled to FROM(I).
DETLO(I)	The visibility value for a low elevation node is stored in this array.
DETHI(I)	The visibility value for a high elevation node is contained in this array.
DIST(I,J)	The distance between a primary route node and the neighborhood nodes are stored in DIST. The I value is for low elevation nodes and the J value is for high elevation nodes.
SYSR(I)	This array has the weapon system kill radius in km. This value is converted to the units used by the model. If the first value is zero, then radar avoidance weighting is not used.
SR(I,J)	The range between the current node and the sensor, the angle to the sensor and the angle of coverage are stored in this array. This information is used for the radar avoidance weighting.
	Arrays not in COMMON
MPOINT(I)	For small lists which need pointers this array is set equivalent to the last part of IPOINT to save core storage. This array is used in several subroutines in this manner.
IFINISH(I)	To keep up with the progress of the LOS calculations in RADIAL, this array has the bits of an array element set to one as each nodesensor pair is completed. The zero through nine bit are used for low elevation nodes and up to 10 sensors. The ten through nineteen bit are used for high elevation nodes.
NLIST(I)	After the route is found, the smoothing routine stores the modified route in this array.

#### Variables in COMMON

**JSTRIP** The current map sheet that is being used by the model. **KCET** The number of clusters that are found is stored in this variable until it can be added to either NLOW or NHI depending on whether it is low or high elevation clusters. NLOW This variable is the total number of low elevation nodes found plus the initial and final route nodes. NHI The total number of high elevation nodes found is stored in this variable. **SMAX** As the node-sensor combinations are being processed the maximum distance is checked. If a distance is found which is greater than SMAX then the new value is assigned to SMAX. **NBLKS** This variable is the number of data blocks written on to temporary storage. LWRIT This variable is used to obtain detail data on the operations of the model. It is mainly used for checking results. IF LWRIT > 5 then everything is printed. As this variable increases in value the amount of printing decreases. A value over 3 turns off the detail printing. **LDEBG** To debug the clustering portion of the model this variable can be set ≠ 1. LALT The minimum elevation for the map sheet currently being used. HALT The maximum elevation for the current map sheet. LH If LH is set to 1 then low elevation points are being processed. IF LH is 2 then high elevation points are being processed. **SENALT** The altitude of the sensor above local terrain is entered in this variable. **VEHALT** The vehicle altitude it will be flying above local terrain. Can be used for a ground vehicle by setting it to zero. **NSITE** The number of sensors that are located in the area

used.

of interest. A maximum of ten can currently be

RE	This variable is the radius of the earth for use in the LOS calculations to allow for earth curvature.
MDIM	This variable is the number of data points in the terrain data array. It is now set for a 15 by 15 array.
GRID	The grid interval (in meters) between the terrain data points. From this research the grid interval was 70 meters.
SWEA	The easting of the southwest corner of the terrain area being analyzed.
SWNR	The northing of the southwest corner.
LTRS	The UTM letter designation for the grid zone of the southwest corner.
IRADUS	The radius value to be used to determine a neighborhood of nodes. A value of 15 (1 km) is currently being used.
LNEBR	The number of low elevation nodes within the neighborhood for the current route node being evaluated.
KNEBR	The number of high elevation nodes within the neighborhood.
IROW	The row value (y-axis) of the current route node being evaluated.
JCOL	The column (x-axis) of the current route node being evaluated.
KFIRST	The location of the initial route node within the LOWCEN array.
KLAST	The location of the terminal or destination node within the LOWCEN array.
IC	The number of nodes that the route passes through.
IFREE	The total number of linkages that were found as the route was being developed.
RANGE	The range at which the weighting scheme narrows the search area down. When the terminal point is within 1 km of the current position the field of view is narrowed down to 90°. Node points outside these parameters have a higher weight assigned to them.

The maximum number of terrain data arrays in the north-south direction is assigned this variable.

ISTRIP

This variable is set equal to the number of map sheets being used.

JMAT

The current array within a map sheet that is being used by the model.

RATE

The distance between terrain points in the data

base that are being used. In this research every data point is used thus RATE is set to one.

## Subroutine RADIAL Variables

NORTH SOUTH EAST WEST	These variables are the map sheet boundaries and the names correspond to the boundary edge.
ZCURVE	This parameter is a logical value that be set if curvature of the earth is used for LOS calculations.
DZ	The amount of curvature that is present when correcting for earth curvature.
XSIT,XP YSIT,YP ZSIT,ZP KSIT	These variables are the X, Y and Z coordinates of the sensor that is currently being used in the LOS calculations. The KSIT value is the integer value of XSIT.
XS1 YS1 ZS1 KS1	These variables are the X, Y and Z coordinates of the current node being processed by RADIAL. The KS1 is the integer value of XS1.
XSP YSP ZSP	The difference between the sensor and node are found for each coordinate and stored in these variables.
DIS RMAX	This variable is the vector distance between the sensor and node in the X-Y plane. RMAX is set equivalent to DIS.
R	This variable is the vector distance from the node to the terrain point in the data base that LOS is being checked.
TM	The tangent to the eastern point from the horizontal is stored in this variable.
Т	The tangent to the terrain is calculated and stored in variable for comparison with TM.
YWEST	The Y component of the tangent T on the west map edge is contained in this variable to correct for vector crossing map sheets.
Z	The elevation of the current terrain point being checked for masking is assigned to this variable.

XSIN	The sine of the azimuth angle measured clockwise from north for the node-sensor vector is stored in this variable.
YCOS	This variable is the cosine of the azimuth angle.
ZNORTH ZSOUTH	These variables are logicals to indicate whether the vector is heading north or south.
NAR	This variable is the array within the map sheet where the terrain point is located.
X,IX	These variables are the x coordinate for the current terrain point.
Υ, JΥ	These variables are the y coordinate for the current terrain point.
YDZ, JDY	These variables are the increment in X and Y respectively.
IFIN	This variable is used to check for completion of a sensor-node pair.
IEXP	The sensor bit in IFINISH is set by using the exponent of 2 corresponding to the bit location in the computer word.
RTOD	This variable is the number of radians to degrees.
EAST1 NORTH1	The easting and northing of the beginning of a route segment or path leg along the route.
EAST2 NORTH2	The easting and northing of the end node of the route segment that begins at EAST1,NORTH1.
Subroutine DIFFER Variables	
DMIN	The minimum distance between any node in the neighborhood of the current route node being processed.
DMAX	The maximum distance between any node in the neighborhood of the current route node being evaluated.
DRANG	The difference between DMAX and DMIN is assigned this variable.
KZMIN	The minimum elevation for any node in the neigh- borhood for the route node being evaluated.

The maximum elevation for any node in the neigh-**KZMAX** borhood for the route node being evaluated. **KZRANG** The difference of KZMAX less KZMIN is assigned this variable. Subroutine LINKAGE Variables **NWEIG** This variable is the weight a node point has because of its location with respect to the current route node. **IFLAG** If the procedure cannot find any node points in a neighborhood of a route point, the rectilinear distance for a neighborhood is doubled. IFLAG is then set to -1 and the model stops if no nodes still cannot be found. **NPEN** This variable is the weight exposure value the penalty function calculates for the node in the neighborhood. This variable is used to store the current mini-**LPEN** mum NPEN that has been found. The node in the neighborhood with the current **NEWPT** minimum exposure is assigned to NEWPT. The X coordinate difference between the route XI.IX node and the neighborhood node is stored in these variables. The Y coordinate difference for the same two YJ,JY nodes as XI above. **KANG** The angle at which the terminal node lies from the current route node is measured from the x-axis and assigned to KANG. This angle is the direction of a neighborhood **IANG** node from the route node. IAK This angle is the difference between KANG and The range from the route node to the terminal RANG node is stored in this variable.

borhood node.

This range is from the route node to the neigh-

RA

FORTRAN LISTING

```
PROGRAM SEARCH(INPUT=/80.0UTPUT=/137.TAPE5=INPUT.
     1 TAPE &= OUTPUT , TAPE 7 , TAPE 8 , TAPE 9)
      CCMMON/ICAT/ KMAT, ISTRIP, IDATA(15, 15, 10)
      COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NHI.
         SMAX.LWRIT.LDEBG.JMAT.JSTRIP.LH
      CCMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250).
     1 ISET(250) • MSET(250) • CEROID(250 • 3)
      COMMON/SERVEH/ LALT. HALT. SENALT. VEHALT. IFREE. GRIC.
     1 SMEA.SWAR.LTRS
      COMMON/SRAD/ RANGE.RE.MDIM.RATE.NSITE.ISITE(10.3).SYSR(10)
      INTEGER FALT.CERCID.HICEN.GRID.SWEA.SWAR.SAVETP
      INTEGER SENALT. VEHALT
      DATA INT KMAT ISTRIP GRID RANGE/10.10.10.70.14.3/
      DATA KCET + LWRIT + LDEBG + NLOW + NHI/0 + 1 + 1 + 0 + 0/
C
С
 *** KMAT IS SET UP FOR 10 ARRAYS WITHIN A STRIP OF DATA
C
 *** ISTRIP IS SET UP FOR 10 STRIPS **
C
      NSITE = 3
      LWRIT = 3
      LDEBG = 1
 *** READ INPUT DATA **
C
C
      REAC(5.900) ISTRIP.KMAT.SAVETP.LWRIT.LCEPG
      READ (5,901) INT, GRID, LTRS, SWEA, SWAR
      READ(5.902) SENALT, VEHALT, IRADUS, RANGE, RE, RATE, MDIM
      READ(5,903) INITIAL(2), INITIAL(1), INITIAL(3)
      READ(5,903) LAST(2), LAST(1), LAST(3)
      READ (5.904) NSITE
      IF(NSITE .GT. 10) GO TO 1200
  100 DO 125 I=1.NSITE
      READ (5,903) ISITE (1,2), ISITE (1,1), ISITE (1,3)
      READ(5,905) SYSR(I)
  125 SYSR(I) = SYSR(I) * 1000 • 0/GRID
C
      WRITE(6,510)
      DC 1000 JK=1.ISTRIP
      JSTRIP = JK
      CALL INDATA
 *** GROUP DATA INTO ALTITUDE BANDS
 *** INT IS THE BAND INTERVAL
 *** JMAT IS THE MATRIX BEING SUBDIVIDED FOR ANALYSIS
С
C
      DO 660 I=1.15
      DO 660 J=1.15
      CO 660 K=1.KMAT
  660 IDATA(I,J,K)=(((IDATA(I,J,K)-1)/INT)+INT)+INT
C
  *** FIND THE LOCATION OF THE SENSORS IN THE TERRAIN DATA
```

```
DO 700 I=1.NSITE
      ICOL = JK * 15
      NX = ISITE(I_{\bullet}2)
      IF(NX .GT. ICCL) GO TO 700
      ICOL = (JK-1)*15
      IF(NX .LT. ICOL) GC TO 700
      NX = NX-(JK-1)*15
      NY = ISITE(I,1)
      NZ = (NY-1)/15
      NY = NY-NZ*15
      NZ = NZ+1
      ISITE(I.3) = IDATA(NY.NX.NZ)
  700 CONTINUE
      IF (LWRIT .LE. 4) GO TO 675
      DO 501 K=1.KMAT
      WRITE(6,911)
  501 WRITE(6,912) ((IDATA(I,J,K),J=1,15),I=1,15)
      WRITE(6,510)
C *** MINALT FINDS MIN AND MAX ELEVATION IN EACH ARRAY
C
 *** HILCELV CVERSEE THE CLUSTERING OF ELEVATION BANDS
C
  675 DO 800 JJ=1+KMAT
      JMAT = JJ
      IC=1
      IK=1
      CALL MINALT(IC.IK)
      CALL HILGELV(IC.IK.1)
      IF(IC .EG. 225) GO TO 800
      CALL HILOELV(IK, IK, 2)
  800 CONTINUE
 1000 CCNTINUE
      WRITE (6.910)
      WRITE(6,915) ISTRIP+KMAT+SAVETP+LWRIT+LDEEG
      WRITF(6,916) INT, GRID, LTRS, SWEA, SWAR
      WRITE(6.517) SENALT. VEHALT. IRADUS. RANGE. RE. RATE. MDIM
      WRITE(6.518) INITIAL(2).INITIAL(1).INITIAL(3)
      WRITE(6,919) LAST(2), LAST(1), LAST(3)
      WRITE(6,913)
      DO 1100 I=1.NSITE
 1100 WRITE(6,520) ISITE(1,2), ISITE(1,1), ISITE(1,3), SYSR(1)
      CALL LINKAGE
      IF (SAVETP .GT. 0) CALL SAVE
      STOP
 1200 WRITE(6,914) NSITE
      NSITE = 10
      GC TO 100
C
  900 FCRMAT(515)
  901 FCRMAT(215.10X.A2.214)
  902 FCRMAT(315.3F10.3.15)
  903 FORMAT(3110)
```

```
904 FORMAT(IS)
905 FORMAT(F10.2)
910 FORMAT(1+1)
911 FORMAT(/10X+*ALTITUDE ARRAY*/)
912 FORMAT(15(1X,16))
913 FORMAT(20X+*SENSOR LOCATION*/24X+*X*+7X+*Y*+7X+*Z*+
   1 7X , *SYS R *)
914 FORMAT(////5x+*NUNBER OF SITES GREATER THAN 10 -*+16/
   1 6X.*NSITE SET TO 10*)
515 FORMAT(//20x + *INPUT DATA * / 20X + *ISTRIP KMAT SAVETP * +
   1 *LWRIT LDEBG*/ 20X,5(15,1X))
916 FCRMAT(/20X+*INT GRID LTRS SWEA SWAR*/
   1 20X+2(I5+1X)+A2+2(1X+I5))
917 FORMAT(/20X ** SENALT VEHALT IRADUS RANGE
   1 *RATE MDIM*/20X,3(I5,1X),F8.3,1X,F10.2,1X,F8.3,1X,IE)
918 FORMAT(/20X+*INITIAL POINT ON ROLTE - X+Y+Z*/
   1 20X+3(16+2X))
919 FORMAT(/20X+*CESTINATION POINT FOR ROUTE - X+Y+Z*/
   1 20X+3(16+2X))
920 FORMAT(20X+3(15+3X)+F10+3)
    END
```

```
SUBROUTINE HILOELV(IC.IK.ILO)
 *** THIS SUBROUTINE CONTROLS HIGH/LOW CLUSTERING
      IC IS THE NUMBER OF MEMBERS IN LOWCEN
 *** IK IS THE NUMBER OF MEMBERS IN HICEN
 *** LOWCEN CONTAINS THE LOW ELEVATION CENTROIDS
 *** HICEN CONTAINS THE HIGH ELEVATION CENTROICS
 *** NLOW IS THE NUMBER OF LOWCEN CENTROIDS
C
 *** NHI IS THE NUMBER OF HICEN CENTROIDS
 *** KCET IS CURRENT COUNT OF CLUSTER MEMBERSHIP
      COMMON/IDAT/ KMAT.ISTRIP.IDATA(15.15.10)
      COMMON/LCENT/ LCWCEN(250+3)+HICEN(250+3)+KCET+NLOW+NHI+
         SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH
      COMMON/POINT/ INITIAL(3), LAST(3), IPOINT(250),
     1 ISET(250), MSET(250), CEROID(250,3)
      COMMON/SENVEH/ LALT.HALT.SENALT.VEHALT.IFREE.GRID.
     1 SWEA.SWNR.LTRS
      INTEGER HALT OCERCIDOHICEN
C
      IF(ILC .EG. 2) GC TO 20
 *** PROCESS LOWCEN **
 *** IF IC=1 ONLY CHE VALUE WAS FOUNDR MEMBERSHIP
C
 *** IF IC=225 THEN ALL THE ELEVATION VALUES ARE THE SAME
C
 *** THE SAME LOGIC IS USED FOR IK
C
      LF = 1
      IF(IC .EG. 1)
                      GO TO 500
      IF(IC .EG. 225) GO TO 550
      CALL CLUST(IC)
      GO TO 610
  500 IPOINT(1) = 1
      GO TO 600
  550 IPOINT(1) = 113
 600 CALL CALCEN(1)
 610 CONTINUE
 *** STORE NEW MEMBERS
      DO 625 L=1.KCET
      LOWCEN(NLOW+L.1) = CEROID(L.1)
      LOWCEN(NLOW+L.2) = CEROIC(L.2)
  625 LOWCEN(NLOW+L+3) = CEROID(L+3)
      NLOW = NLOW+KCET
      KCET = C
      CC 650 L=1,250
      ISET(L) = 0
  650 IPOINT(L) = 0
      RETURN
C
  *** FROCESS HICEN
```

```
20 Lh = 2
      CO 100 I=1.IK
  100 ISET(I) = MSET(I)
      IF(IK .EQ. 1)
                     GO TC 700
      IF(IK .EQ. 225) GO TC 750
      CALL CLUST(IK)
      GO TC 810
  760 IPOINT(1) = 1
      GO TO 800
  750 \text{ IPOINT(1)} = 113
  PCO CALL CALCEN(1)
  810 CONTINUE
C *** STORE NEW MEMBERS **
      DC 825 L=1.KCET
       HICEN(N+I+L+1) = CEROID(L+1)
       HICEN(NHI+L+2) = CEROID(L+2)
 825 HICEN(NHI+L+3) = CEROID(L+3)
      NHI = NHI+KCET
      KCET = 0
      DO 850 L=1.250
      ISET(L) = 0
 850 IPOINT(L) = 0
      RETURN
      END
```

```
SUBROUTINE INDATA

COMMON/IDAT/ KMAT + ISTRIP + IDATA (15 + 15 + 10)

COMMON/LCENT/ LOWCEN(250 + 3) + HICEN(250 + 3) + KCET + NLOW + NHI +

1 SMAX + LWRIT + LDEBG + JMAT + JSTRIP + LH

INTEGER HALT

C

C *** READ INPUT TERRAIN DATA **

C

READ(8) LALT + HALT

CO 600 IMAT = 1 + KMAT

600 READ(8) ((IDATA(IRCW + ICOL + IMAT) + IROW = 1 + 15) + ICOL = 1 + 15)

RETURN
END
```

```
SUBROUTINE MINALT(IC+IK)
C
C *** THIS SUBROUTINE FINDS THE MIN AND MAX ELEVATION
 *** BANDS IN EACH GMAT ARRAY OF IDATA. IVAL IS THE
C
 *** ARRAY ELEMENT THAT IS BEING CHECKED FOR MIN/MAX
C
      COMMON/LCENT/ LOWCEN(250,3).HICEN(250,3).KCET.NLOW.NFI.
         SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPCINT(250).
     1 ISET(250), MSET(250), CEROID(250,3)
      COMMON/IDAT/ KMAT, ISTRIP, IDATA (15, 15, 10)
      INTEGER CEROIC . HICEN
C
      CO 5 I=1.250
      MSET(I) = 0
    5 ISET(I) = 0
   20
         IFF
               = 1
               = 15
         IL
         JF
               = 1
               = 15
         JL
  600 MIN VAL = 999999
      MAX VAL = -959999
C
 *** FOR IVAL
C
 *** A POSITIVE VALUE INDICATES IVAL OUTSIDE CLUSTER
C
 *** A ZERO VALUE - IVAL IN CLUSTER
C
 *** A REGATIVE VALUE INDICATES A NEW CLUSTER
C
      DC 800 I=IFF.IL
      DC 800 J=JF.JL
      (TAML-IDATA(I,J,JMAT)
      IF(IVAL - MIN VAL) 700,750,625
  625 IF(MAX VAL - IVAL) 650,660,800
C
 *** STORE INCICES FOR I AND J WITH MAXIMAL VALUE IN MSET
C
 *** IK IS A COUNT OF THE VALUES FOUND
C
  650 IK = 0
      MAX VAL = IVAL
  660 IK = IK+1
      MSET(IK) = I*100+J
      GO TO 800
 *** STORE INDICES FOR I AND J WITH MINIMAL VALUE IN ISET
C
 *** IC IS A COUNT OF THE VALUES FOUND
C
  700 IC=0
      MIN VAL = IVAL
  750 IC = IC+1
      ISET(IC) = I*100+J
  800 CONTINUE
      RETURN
      END
```

```
SUBROUTINE CLUST(IC)
      COMMON/LCENT/ LOWCEN(250,3), HICEN(250,3), KCET, NLOW, NHI,
         SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH
      COMMON/PCINT/ INITIAL(3).LAST(3).IPCINT(250).
     1 ISET(250), MSET(250), CEROID(250,3)
      INTEGER CEROID. HICEN
 *** THIS SUBROUTINE FINDS THE MEMBERS OF EACH CLUSTER
C *** IPOINT STORES THE INDEX OF ISET FOR THE CURRENT CLUSTER
C *** I IS THE BEGINNING OF THE ISET CLUSTER
C *** J IS THE CURRENT VALUE IN ISET BEING EVALUATED
 *** FOR INCLUSION IN THE CLUSTER
      I = 1
   30 K=1
      IPOINT(1)=I
   35 \ J = I+1
   40 IVAL = ISET(J)-ISET(I)
   52 IF((IVAL.EG.1).CR.(IVAL.EG.99).OR.(IVAL.EG.100).OR.
         (IVAL.EG.101)) GO TO 60
 *** TRUE - INCREMENT I
      IF(IVAL .GT. 101) GO TO 54
C *** TRUE - J IS PAST LAST ENTRY
      IF(IVAL .LE. 0) GO TO 82
      J = J+1
      IF( J .GT. (I+16)) GC TO 70
      GO TC 40
   54 IF((I+1) .EG. J) GO TO 85
      I = I+1
      GC TO 35
C
C *** PLACE IVAL INTO CLUSTER USING ITS INDEX
   60 DC 62 L=1+K
   62 IF (IPOINT(L) .EG. J) GO TO 64
      K = K+1
      IPGINT(K) = J
   64 \ J = J+1
      GO TO 40
C
 *** NO CHANGE IN K INDICATES THAT NO NEW MEMBERS EXIST
   70 IF(K .EG. 1) GO TO 75
        I = I+1
        GO TO 35
 *** ISOLATED POINT
   75 CALL CALCEN(1)
      I = I+1
      IF(I .GT. IC) RETURN
      GO TC 30
```

```
82 IF((I+1) .LT. IC) GO TO 84
    DC 83 L=1.K
83 IF(IPCINT(L) .EQ. (J-1)) GC TO 90
    I = I+1
    IF(I .GT. IC) GO TO 90
    GO TO 35
84 I = I+1
    GO TO 35
85 CALL CALCEN(K)
    I = I+1
    GO TO 30
C
C *** END CLUSTER ***
C
90 CALL CALCEN(K)
    RETURN
    END
```

```
SUBROUTINE CALCEN(K)
С
C
  *** CETERMINE THE CENTROID OF THE CLUSTER
      COMMON/IDAT/ KMAT. ISTRIP. IDATA(15,15,10)
      COMMON/LCENT/ LCACEN(250,3), FICEN(250,3), KCET, NLOW, NFI,
         SMAX.LWRIT.LDEBG.JMAT.JSTRIP.LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250).
     1 ISET(250), MSET(250), CERCID(250,3)
      COMMON/SENVEH/ LALT.HALT.SENALT.VEHALT.IFREE.GRID.
     1 SWEA+SWNR+LTRS
      INTEGER CEROIC. HICEN. HALT
C
 *** INUM IS THE RCW INCEX - Y COORD
  *** JNUM IS THE CCLUMN INDEX - X COORD
С
С
      KDUM = 0
      JNUM = 0
      INUM = C
      KCET = KCET+1
С
  *** CALCULATE THE MEAN VALUES
      DC 100 L=1.K
       LL = IPCINT(L)
       KDUM = ISET(LL)/100
       JNUM = (ISET(LL) - KDUM +100) + JNUM
      INUM = KOUM + INUM
  100
С
С
  *** THIS CALCULATION ADDS A HALF TO ALLOW FOR TRUNCATION
C
      JNUM = (2*JNUM+K)/(2*K)
      INUM = (2*INLM+K)/(2*K)
      IF(JNUM .GT. 15) JNUM=15
      IF (INUM .GT. 15) INUM=15
C *** NEED TO STORE WHICH ARRAY IS BEING PROCESSED
      MUNI + 2I + (I - TAMU) = WCRI
      ICOL = (JSTRIP-1) *15+JNUM
      CEROID(KCET+1) = IROW
      CEROID (KCET+2) = ICOL
      CEROID (KCET,3) = IDATA (INUM, JNUM, JMAT)
      IF(LWRIT .LE. 3) GC TO 10
      CALL WRITCL(K)
   10 IF(LDEBG .EQ. 1) RETURN
C
      WRITE(6.900) KDUM, STRIP, JMAT, INUM, JNUM, KCET,
     1 CEROID(KCET,1),CEROID(KCET,2),CEROID(KCET,3),IROW,ICOL
  900 FORMAT(10X++KDUM
                          JSTRIP JMAT INUM
                                               JNUM * , 2 X ,
                        CEFOID(I+1)+(I+2)+(I+3) IROW
     1
             10x,6(I5,1x),5x,3(I6,2x),2(I5,1x))
     2
      WRITE(6.901) NLOW-NHI-LALT-HALT-LH
```

501 FORMAT(10X+\*NLOW NHI LALT HALT LH\*/
1 10X+5(15+1X))
RETURN
END

```
SUBROUTINE WRITCL(K)
C
  *** THIS SUEROUTINE WRITES RESULTS OF CLUSTERING
C
  *** LH - 1 IS LOWCEN. 2 IS HICEN
C
      COMMON/LCENT/ LCWCEN(250,3). FICEN(250,3). KCET. NLOW. NHI.
         SMAX, LWRIT, LDEEG, JMAT, JSTRIP, LH
      COMMON/PCINT/ INITIAL(3) . LAST(3) . IPOINT(250) .
     1 ISET(250) • MSET(250) • CERGID(250 • 3)
      INTEGER CERCID . HICEN
      DATA NEXT, NEXTL, NEXTH/1,1,1/
      NEXT = NEXTL
      IF(LH .EG. 2) NEXT=NEXTH
      WRITE (6,900)
  900 FCRMAT(///)
      IF(LH .EG. 1) WRITE(6,901)
      IF(LH .EG. 2) WRITE(6,902)
  901 FORMAT(//10x + + LOW ELEVATION CLUSTER +//)
  902 FCRMAT(//10x,*HIGH ELEVATION CLUSTER*//)
      WRITE (6,903) NEXT+K
      WRITE (6.904) (IPOINT(I).I=1.K)
  903 FORMAT(5X+*CLUSTER NUMBER *+14/
     1 5X ** TOTAL MEMBERS IN CLUSTER **, 13/)
  904 FORMAT(5x**PCINTERS TO CLUSTER MEMBER*/10(2X*18))
      N1 = IPCINT(1)
      N2 = IPOINT(K)
      WRITE (6,905) (ISET(I), I=N1,N2)
      WRITE (6,906) NEXT+CEROID(KCET+2)+CERCID(KCET+1)+
                     CEROID (KCET +3)
  905 FORMAT(/EX+*FACKED CLUSTER LOCATION RCW-COLUMN*/10(2X+I8))
  906 FORMAT( // 5x, *CENTER OF CLUSTER NUMBER *, 14/
             5X + * X - COORD * + I4 + * Y - COORD * + I4 + * Z - COORD * + I4 / / / )
      NEXT = NEXT+1
      IF(LH .EG. 1) NEXTL=NEXT
      IF(LH .EG. 2) NEXTH=MEXT
      RETURN
```

END

#### SUBROUTINE LINKAGE C C \*\*\* LINKAGE ROUTINE \*\*\* IPCINT HAS LIST OF NEIGHEORHOOD POINTS NODE - NODE NUMBER OF POINT BEING EVALUATED NLOW - NUMBER OF POINTS IN LOWCEN - NUMBER OF POINTS IN HICEN NHI \*\*\* LNEBR - POINTS IN NEIGHBORHOOD FOR LOWCEN \* \* \*\*\* KNEBR - POINTS IN MEIGHBORHOOD FOR HICEN \* \* COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NHI. SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH COMMON/POINT/ INITIAL (3) . LAST(3) . IPCINT(250) COMMON/SENVEH/ LALT. HALT. SENALT. VEHALT. IFREE. GRID. 1 SWEA . SWNR . LTRS CCMMON/SRAD/ RANGE.RE.MDIM.RATE.NSITE.ISITE(10.3).SYSR(10) CCMMON/KINK/ LINK(250).LINKTO(1500.3).NBLKS.IC. 1 IRADUS.LNEBR.KNEBR CCMMON/CET/ CETLO(250) DETHI(250) FRCM(250) TO(250+2) CCMMON/EDGE/ DIST(100.2).IRCW.JCCL.LSTR CIMENSION MPCINT(125) + SR(10+3) + NLIST(250) INTEGER HICEN . GRID . FROM . TO . SWEA . SWNR INTEGER EAST1. EAST2 EQUIVALENCE (IPOINT(126), MFOINT(1)) CATA IRACUS/15/ DATA DETLO.DETHI/500+0/ DATA SMAX.RTCD/100.0.57.2957795131/ C NBLKS = OLDS = 1IFREE = KFIRST = KLAST = 0 LTOTAL = C C C \*\*\* SORT LOWCEN AND HICEN C CALL LHSCRT(KFIRST+KLAST) C C \*\*\* DEVELOP NETWORK CALL RADIAL DC 10 I=1,250 FROM(I) = 0TO(I+1) = 0 $10 \ TO(I \cdot 2) = 0$ C \*\*\* CONSTRUCT ROLTE C 15 IC = 1 NODE = KFIRST

NEWPT = NOCE

C

\*\*\* FIND REIGHBORHOOD ABOUT A LOW POINT

```
20 IROW = LOWCEN(NODE +1)
      JCOL = LOWCEN(NODE,2)
      LCWCEN(NCDE+1) = -(1000000+IROW)
      LOWCEN(NODE+2) = -(1000000+JCOL)
      CALL NEIGHB (NODE)
      CALL DIFFER(NODE)
C
   30 FROM(IC) = NEWPT
      IF(LWRIT .LE. 2) GC TO 35
      WRITE(6,921) NODE, JCCL, IROW, NEWPT, LPEN, IC
   35 \times I = LAST(2) - LCOL
      YJ = LAST(1)-IROW
      KANG = RTOD * (ATAN2(YJ,XI))
      RANG = SGRT(XI**2 + YJ**2)
      DO 50 I=1.NSITE
      XI = ISITE(I,2)-JCOL
      YJ = ISITE(T.1)-IROW
      SR(I+1) = SQRT(XI**2 + YU**2)
      IF((XI .EG. C.0) .OR. (SR(I.1) .EG. 0)) GO TO 50
      SR(I+2) = RTCD*(ATAN2(YJ+XI))
      SR(I \bullet 3) = ABS(RTOD*(ATAN2(SYSR(I) \bullet SR(I \bullet 1))))
   EG CONTINUE
C
           FIND MIN PENALTY VALUE
C ***
 *** ANGLE HEADING IS MEASURED FROM X-AXIS
 *** IAK ANGLE IS MEASURED FROM HEADING
                                                 * *
 *** THREE WEIGHTING SCHEMES
C
  *** HEADING. RADAR AVOIDANCE. TERMINAL
C
      LFEN = 1000000
      LA
          = LINK(IC)
           = LINK(IC+1)-1
      LE
      IF(L6 .LE. 0) L6=IFREE
      CO 200 LL=LA.LB
      NJ = LINKTO(LL + 1)
      IF(NJ .LT. 0) GO TO 120
      IX = LOWCEN(NJ + 2)
      JY = LOWCEN(NJ.1)
      GC TO 125
  120 IX = HICEN(-NJ_{\bullet}2)
      JY = FICEN(-NJ \cdot 1)
  125 XI = IX-JCOL
      YJ = JY-IRCW
      RA = SGRT(XI**2 + YJ**2)
      IANG = RTCD+(ATAN2(YJ\bulletXI))
      IAK
            = IANG-KANG
      IF(IAK .GT. 180) IAK=360-IAK
      IF(IAK .LT.-180) IAK=360+IAK
C *** FEADING WEIGHTING
      NWEIG = (IABS(IAK))/90+1
```

```
IF (RANG .GT.RANGE) GO TO 130
C
C
  *** TERMINAL WEIGHTING **
С
      NWEIG = 2*(IABS(IAK)/45)+1
      IF(RA .GT. RANG) NWEIG=10C+NWEIG
      GO TO 150
C
 *** RADAR AVCIDANCE WEIGHTING
 130 IF(SYSR(1) .LE. 0.0) GO TO 150
      DC 135 I=1.NSITE
      ANG = IANG
      ANG = ABS(SR(I+2)-ANG)
      IF(ANG .GT. SR(I.3)) GO TO 135
      NWEIG = 2
      IF(RA .GT. (SR(I.1)-SYSR(I))) NWEIG=10
      GO TO 150
  135 CONTINUE
  150 RPEN = NWEIG+LINKTO(LL+2)+NWEIG
      LINKTO(LL.3) = NPEN
C
      IF(LWRIT .LE. 2) GO TO 175
      WRITE(6,520) NODE, NJ. LA. LB. IC. IFREE, RANGE, RANG. RA
      WRITE(6,924) IAK.IANG.KANG.NWEIG.LPEN.NPEN.XI.YU
  175 IF (NPEN .GE. LPEN) GO TO 200
      LPEN = NPEN
      MEMPT = LINKTO(LL+1)
  200 CONTINUE
C
      IF(LWRIT .GT. 2) WRITE(6,921) NOCE, JCOL, IROW, NEWPT, LPEN, IC
      IF (NEWPT .EG. KLAST)
                            GO TO 475
               = NEWPT
      NCDE
      TC(IC.1) = NEWPT
      TC(IC.2) = LFEN
      I C
               = IC+1
               = LTOTAL+LPEN
      LTOTAL
      IF(IC
               •GE • 1950) CALL RITE
      IF(IFREE .GE. 1800) CALL RITE
                          GO TC 400
      IF(NOCE .LT. 0)
      GO TO 20
C *** FIND REIGHEORHOOD ABOUT A HIGH POINT
  400 NODE = -NEWPT
      IROW = HICEN(NODE,1)
      JCOL = HICEN(NODE +2)
      HICEN(NODE+1) = -(1000000+IROW)
      HICEN(NOCE_{+}2) = -(1000000+JCOL)
      CALL NEIGHE (NODE)
      CALL DIFFER(NCDE)
      GC TO 30
```

```
450 IF(IFLAG .EG. -1) GO TO 475
      IFLAG =-1
      IRADUS = 2 * IRADUS
      GO TO 15
  475 TO(IC.1) = NEWPT
      TO(IC.2) = LPEN
С
C
  *** CHECK FOR DATA BLOCKS WRITTEN TO WORKING STORAGE
C
      IF(NeLKS .GT. 1) GO TO 700
C
 *** REMOVE LARGE REGATIVE VALUE FROM ROUTE NODES
  480 DO 500 I=1.IC
      NN = FROM(I)
      IF(NN .LT. 0) GO TC 485
      LCWCEN(NN+1) = -(LCWCEN(NN+1)+1000000)
      LCWCEN(NN+2) = -(LCWCEN(NN+2)+1000000)
      GO TO 500
  485 NN = -NN
      HICEN(NA.1)
                    = - (HICEN(NN+1) +1000000)
      HICEN(NN_{•}2) = -(HICEN(NN_{•}2) + 10000000)
  500 CONTINUE
C
 *** WRITE NOTE POINTS OF THE ROUTE
      LL = 0
      WRITE(6,910)
      DO 650 I=1.IC
      LL = LL+1
      NOD1 = FROM(I)
      NOD2 = TC(I,1)
      IF (NOD1 .LT. 0) GO TO 550
      NCRTH1 = GRIC+LOWCEN(NOD1+1)+SWNR
            = GRIC+LOWCEN(NCD1+2)+SWEA
      EAST1
      IF(NOD2 .LT. 0) GC TO 575
 525 NORTH2 = GRIC+LOWCEN(NOD2+1)+SWNR
      EAST2 = GRIC+LONCEN(NCD2+2)+SWEA
      GC TC 600
 550 \text{ NOD1} = -\text{NOD1}
      NORTH1 = GRIC+HICEN(NOD1+1)+SWNR
      EAST1 = GRIC *HICEN(NOD1 +2) + ShEA
     IF(NOC2 .GT. 0) GO TO 525
 575 NOD2 = -NOD2
     NORTH2 = GRIC+HICEN(NOD2+1)+SWNR
     EAST2 = GRID + HICEN (NOD2 +2) + SWEA
 600 WRITE(6,911) FROM(I), EAST1, NORTH1, TO(I,1),
                   TO(I+2) .EAST2 .NORTH2
     IF(LL .LE. 25) GO TO 650
     WRITE (6,510)
     LL = 0
 656 CONTINUE
```

```
WRITE(6,512) LTRS, SWEA, SWNR, LTOTAL
   CALL WRLINK
   ICK = IC-1
       = 0
   LA
         = 1
    CO 800 I=1.ICK
    IF(K .GE. IC) GC TO 850
        = LA+1
    LA
         = FROM(K)
    ΝJ
         = TC(K+1)
    N N
    NLIST(LA) = NJ
    IF(NJ .LT. 0) GO TO 670
    JCOL = LCWCEN(NJ+2)
    IROW = LCWCEN(NJ.1)
    GC TC 675
670 JCOL = HICEN(-NJ.2)
    IROW = HICEN(-NJ.1)
675 IF(NN .LT. 0) GO TC 680
        = LCWCEN(NN+2)
    ΙX
    JY
        = LOWCER(NN+1)
    GO TO 685
        = HICEN(-NN+2)
680 IX
         = HICEN(-NN+1)
    JY
685 XI
         = IX-ACCL
         = JY-IRCW
    ΥJ
    DISA = SGRT(XI**2 + YJ**2)
         = K+1
    LL
         = K
    CO 800 J=LL.IC
       = TC(J_{\bullet}1)
    IF(NJ .LT. 0) GO TO 690
         = LCWCEN(NJ+2)
    ΙX
         = LCWCER(RJ+1)
    JY
    GO TO 695
        = HICEN(-NJ+2)
690 IX
         = HICEN(-NJ+1)
    JY
         = IX-JCCL
695 XI
          = JY-IROW
    YJ
    DISB = SQRT(XI**2 + YJ**2)
    IF(DISE .GT. DISA) GO TO 800
          = J+1
    CISA = DISE
800 CONTINUE
          = ICK+1
        = LA+1
    LA
     NLIST(LA) = FROM(I)
850 CONTINUE
     NLIST(LA+1) = TO(IC+1)
     WRITE(6,515)
     DG 875 J=1+LA
 875 WRITE(6.916) NLIST(J).NLIST(J+1)
```

C

```
IF (NBLKS .LT. CLCE) GO TO 710
    RETURN
700 CALL RITE
    OLDB = NELKS-1
    REWIND 9
710 READ(9) NBLKS, IFREE, IC
    READ(9) (FROM(I), I=1, IC)
    READ(9) ((TO(I_{1}J)_{1}=1_{1}), I=1,IC)
    READ(9) (LINK(I), I=1, IC)
    READ(9) ((LINKTO(I.J).J=1.3).I=1.IFREE)
    GO TO 480
910 FORMAT(1H1/////30X+*TABLE
                                      NODE LINKAGE FOR ROUTE *//
   1 19X • *FRCM * • 4 X • *EASTING * • 2X • *NORTHING * •
   2 6X+*TO*+4X+*PENALTY*+3X+*EASTING*+2X+*NORTHING*/)
911 FORMAT(18X+15+2X+2(19+1X)+2X+15+2X+3(19+1X))
912 FCRMAT( //19X+*SOUTHWEST CORNER *+A2+214//
   1 110X+*TOTAL PENALTY*/110X+*RUNNING TOTAL*/110X+112)
915 FCRMAT(1H1/////30X+*TABLE
                                      MODIFIED ROUTE*//
   1 37X • *FROM * • 5X • *TO */)
916 FCRMAT(36X,15,2X,15)
920 FCRMAT(/6x + NODE NJ
                            LA LE IC IFREE RANGE * •
   1 6X+*RANG RA*/5X+6(I4+1X)+3(F8.3+1X))
921 FORMAT(10X+*NOCE X-CRC Y-CRD*/10X+3(14+1X)/10X+*NEWPT*+
            2X + * LPEN
                          IC*/10X+I4+1X+I10+1X+I4)
   1
924 FORMATE EX. * IAK IANG KANG NWEIS
      7x + * NPEN * + 5 X + * XI * + 10 X + * YJ * /
   1 5X+I5+1X+I5+1X+I5+1X+I5+1X+I10+1X+I10+2(F10+4+1X))
    END
```

```
SUBROUTINE LHSORT (KFIRST + KLAST)
C
C *** THIS SUBROUTINE SORTS LOWCEN AND HICEN
C *** IN ASCENDING ORDER BY ROWS
C
      COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NFI.
         SMAX+LWRIT+LDEBG+JMAT+JSTRIP+LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250)
      INTEGER HICEN
C
      NLOW = NLOW+1
      LOWCEN(NLOW,1) = INITIAL(1)
      LOWCER(NLOW . 2) =-INITIAL(2) *LAST(2)
      LOWCEN(NLOW,3) = INITIAL(3)
      NLOW = NLOW+1
      LOWCEN(NLOW+1) = LAST(1)
      LOWCEN(NLOW+2) =-LAST(2)
      LOWCEN(NLOW+3) = LAST(3)
C
C *** LOWCEN
      KK = NLOh-1
      DO 10 J=1.KK
      JJ = J+1
      DO 10 I=JJ.NLOW
      IF (LOWCEN (J. 1) .LE. LOWCEN (I. 1)) GC TO 10
      IS1 = LOWCEN(J_01)
      IS2 = LOWCEN(J_{\bullet}2)
      IS3 = LOWCEN(-3)
      LOWCEN(J+1) = LCWCEN(I+1)
      LOWCEN(J_{\bullet}2) = LCWCEN(I_{\bullet}2)
      LOWCEN(J_{\bullet}3) = LOWCEN(I_{\bullet}3)
      LOWCEN(I \cdot 1) = IS1
      LOWCEN(1.2) = IS2
      LOWCEN(I \cdot 3) = IS3
   18 CONTINUE
C
      IS2 = -INITIAL(2) * LAST(2)
      DO 15 I=1. NLCW
      IF (LOWCEN(I.2) .GT. 0) GO TO 15
      IF(LOWCEN(I.2) .ER. IS2)
                                      KFIRST=I
      IF (LOWCEN(I+2) .EQ. -LAST(2)) KLAST=I
   15 CONTINUE
      WRITE(6,907) INITIAL(2).LAST(2).IS2.LOWCEN(KFIRST.2).
     1 LOWCEN(KLAST+2)+KFIRST+KLAST
  907 FORMAT(/ 2x++initial+,2x++LAST++4x++iS2++6x++LOWCEN-1++
     1 2x++LOWCEN-L++2x++KFIRST++3x++KLAST+/2X+7(16+2X))
      LOWCEN(KFIRST,2) = INITIAL(2)
      LOWCEN(KLAST+2) = LAST(2)
      WRITE(6,906)
      WRITE(6,900)
      KL = 0
```

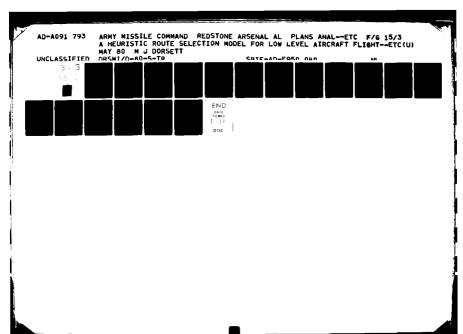
```
DO 20 I=1.NLCW.10
      KK = I-1+10
      IF(KK .GT. NLCW) KK=NLOW
      KL = KL+1
      WRITE(6,901) (LOWCEN(J,2),J=I,KK)
      WRITE (6,902) (LOWCEN(J.1),J=I,KK)
      WRITE(6,903) (LOWCEN(J,3),J=I,KK)
      IF(KL .LE. 7) GO TO 20
      WRITE (6,906)
      WRITE(6.500)
      KL = 0
   20 CONTINUE
      WRITE(6.904) NLOW
C
С
 *** HICEN
C
      KK = NHI-1
      DO 30 J=1.KK
      JJ = J+1
      DO 30 I=JJ.NFI
      IF (HICEN(J.1) .LE. HICEN(I.1)) GO TO 30
      IS1 = HICEN(J+1)
      IS2 = HICEN(L.2)
      IS3 = HICEN(3.3)
      HICEN(J_{\bullet}1) = HICEN(I_{\bullet}1)
      HICEN(J_{\bullet}2) = HICEN(I_{\bullet}2)
      HICEN(J \cdot 3) = HICEN(I \cdot 3)
      HICEN(I \cdot 1) = IS1
      HICEN(I_{•}2) = IS2
      HICEN(I \cdot 3) = IS3
   30 CONTINUE
C
      WRITE(6.906)
      WRITE(6.905)
      KL = 0
      DO 40 I=1.NHI.10
      KK = I - 1 + 10
      IF(KK .GT. N-I) KK=N+I
      KL = KL+1
      WRITE(6,901) (HICEN(J,2),J=I,KK)
      WRITE(6,902) (HICEN(J,1),J=I,KK)
      WRITE(6,903) (HICEN(J,3),J=I,KK)
      IF(KL .LE. 7) GO TO 40
      WRITE(6,906)
      WRITE(6,905)
      KL = 0
   40 CONTINUE
      WRITE(6,904) NHI
      WRITE (6,906)
  900 FORMAT(/////40X+*TABLE
                                      LOW ELEVATION NODE POINTS*//)
  901 FORMAT(18x+*x-COORCINATE *+1017)
```

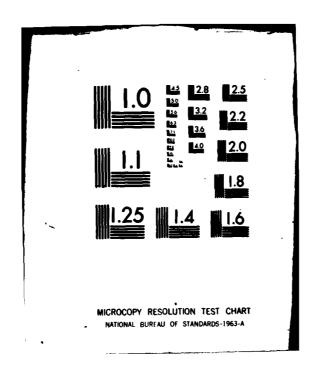
```
902 FORMAT(18X+*Y-COCRDINATE *+1017)
903 FORMAT(18X+*Z-COORDINATE *+1017/)
904 FORMAT(//18X+*NUMBER OF NODES *+15)
905 FORMAT(/////40X+*TABLE HIGH ELEVATION NODE POINTS*//)
906 FORMAT(1H1)
RETURN
END
```

```
SUBROUTINE NEIGHB (NODE)
С
C *** IROW IS ROW INDEX (Y-COORD) BEING EVALUATED
C *** JCOL IS COLUMN INDEX (X-COORD)
C *** NODE LOCATION CURRENTLY BEING PROCESSED
      COMMON/LCENT/ LCWCEN(250,3), HICEN(250,3), KCET, NLOW, NHI,
         SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250)
      COMMCN/SERVEH/ LALT.HALT.SENALT.VEHALT.IFREE.GRID.
     1 SWEA.SWNR.LTRS
      COMMON/KINK/ LINK(250).LINKTO(1500.3).NBLKS.IC.
     1 IRADUS . LNEBR . KNEBR
      COMMON/EDGE/ DIST(100,2), IROW, JCOL, LSTR
      DIMENSION MPOINT(125)
      INTEGER HICEN
      EQUIVALENCE (IPOINT(125), MPCINT(1))
      IRAD = IRADUS
   10 LA = IROW-IRAD
      IF(LA .LE. 0) LA=1
      LB = IROW+IRAD
C *** IBEG IS THE INDEX VALUE WHERE LA = RCW NUMBER
C *** IEND IS THE INCEX VALUE WHERE LB+1 = RCW #
C *** IPOINT HAS INDEX VALUE OF LOWCEN FOR NEIGHBORHCOD
 *** THIS RESTRICTS THE SEARCH TO ONLY THOSE ROWS
                                                           * *
 *** THAT ARE NEAR THE "NODE"
                                                           * *
      CC 100 I=1.NLCh
      AROW = LOWCEN(I+1)
      IF(NROW .LT. LA) GO TO 100
      IEEG = I
      GC TO 101
  100 CCNTINUE
  101 DC 102 I=IBEG.NLOW
      NROW = LOWCEN(I+1)
      IF (NROW .LT. LB) GC TO 102
      IEND = I
      GC TO 103
  102 CONTINUE
C *** FIND THE NEIGHBORHOOD OF LOW ELEVATION POINTS **
  103 \text{ LNEBR} = 0
      DO 104 I=IBEG, IEND
      IF (LOWCEN(I.1) .LT.-1000000) GO TO 164
      LDIFF = IABS(LOWCER(I+1)-IROW)
      IF(LDIFF .GT. IRAD) GO TO 104
      LCIFF = IABS(LOWCEN(I,2)-JCOL)
      IF(LDIFF .GT. IRAD) GO TO 194
      LNEBR = LNEBR+1
```

```
IF(LNEBR .EQ. 100) GO TO 400
      IPOINT(LNEBR) = I
  104 CONTINUE
      IF(LNEBR .EQ. 0)
                        GO TO 300
  125 IFLAG = 0
      DO 200 I=1.NHI
      AROW = HICEN(I.1)
                        GC TO 200
      IF(NROW .LT. LA)
      IBEG = I
      GO TO 201
  200 CONTINUE
  201 DO 202 I=IBEG • NHI
      NROW = HICEN(I \cdot 1)
                        GC TO 202
      IF(NROW .LT. LB)
      IEND = I
      GC TO 203
  202 CCNTINUE
C
C *** FIND THE NEIGHBORHCOD CF HIGH ELEVATION POINTS
C
  203 KNEBR = 0
      CC 204 I=IBEG.IEND
      IF(HICEN(I+1) .LT.-1000000) GO TC 204
      LDIFF = IABS (HICEN(I+1)-IROW)
      IF(LDIFF .GT. IRAD) 60 TC 204
      LDIFF = IABS (HICEN(I.2)-JCOL)
      IF(LDIFF .GT. IRAD) GO TO 204
      KNEER = KNEER+1
      IF (KNEBR .GT. 100) GC TO 500
      MPOINT(KNEBR) = I
  204 CONTINUE
      IF(LWRIT .LE. 2) RETURN
      WRITE(6,500) NOCE, JCOL, IROW
      DC 275 N1=1.LNEBR
      N2 = IPOINT(N1)
  275 WRITE(6,901) N1,N2,LOWCEN(N2,2),LOWCEN(N2,1),LOWCEN(N2,3)
      WRITE(6,902)
      DO 285 N1=1.KNEER
      N2 = PPOINT(N1)
  285 WRITE(6.901) N1.N2.HICEN(N2.2).HICEN(N2.1).HICEN(N2.3)
  900 FORMAT(/EX+* PRIMARY NODE *,14,15,*,X-CCORD *,
     1 I5,*,Y-COORD*/10X,*LOW POINTS*)
  901 FORMAT(10X+*NEIGHE - *+13+* NODE *+13+**+15+
     1 * • X - COORD * • I5 • * • Y - COORD * • I5 • * • Z - CGORD * )
  902 FORMAT(10X+*HIGH POINTS*)
      RETURN
C *** THIS ENSURES THAT AT LEAST ONE POINT BUT NOT MORE
C *** THAN 10G POINTS ARE FOUND
C
  300 IRAD = 2 * IRAC
```

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IF(IRAD .GT. 999999) RETURN
GC TO 10

400 IRAD = IRAD/2
IF(IRAD .EQ. C) GO TC 450
GO TO 10

450 LNEBR = 100
GO TO 125

500 IF(IFLAG .EQ. 1) GO TO 600
IRAD = IRAD/2
IFLAG = 1
GO TC 263
600 KNEBR = 100
RETURN
END

```
SUBROUTINE DIFFER(NODE)
C
 *** THIS SUBROUTINE FINDS RANGE OF HEIGHT AND DISTANCE
C
      DIST(I.1) = THE PLANAR DIST TO PCINT FOR LOWCEN
C
      CIST(I.2) = THE PLANAR DIST TO PCINT FOR FICEN
      DMIN = MIN DIST BETWEEN NOCE AND ADJACENT POINTS
 *** DMAX = MAX DIST BETWEEN NODE AND ADJACENT POINTS
 *** KZMIN = MIN ELEVATION BETWEEN NODE AND ADJ PTS
  *** KZMAX = MAX ELEVATION BETWEEN NODE AND ACJ PTS
С
      COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NHI.
         SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250)
      COMMON/SENVEH/ LALT.HALT.SENALT.VEHALT.IFREE.GRID.
     1 SWEA.SWNR.LTRS
      COMMON/KINK/ LINK(250).LINKTO(1500.3).NELKS.IC.
     1 IRADUS, LNEBR, KNEER
      CCMMON/DET/ CETLO(250).DETHI(250).FRCM(250).TO(250.2)
      CCMMON/EDGE/ DIST(100.2).IRCW.JCCL.LSTR
      DIMENSION MPOINT(125)
      INTEGER HICEN
      EGUIVALENCE (IFCINT(126) + MFOINT(1))
      DATA RTCC+LSTR/57-2957795131+1/
  *** INITIALIZE VARIABLES
      DO 10 I=1.100
      CIST(I \cdot 1) = 0 \cdot 0
   10 DIST(I_{•}2) = 0.0
      DMIN
           = 1000000
      DMAX =-1000000
      KZMIN = 1000000
      KZMAX =-1000000
C
  *** FROCESS LOWCEN
C
      DC 130 I=1+LNEER
          = IPOINT(I)
          = LOWCEN(J.1)-IROW
      YJ
          = LOWCEN(J.2)-JCOL
      ΧI
      KZI = LOWCEN(3.3)
      IF(KZI .GE. KZMIN) GO TO 15
      KZMIN = KZI
   15 IF(KZI .LE. KZMAX) GC TO 20
      KZMAX = KZI
   20 CONTINUE
      DIST(I_{\bullet}1) = SQRT(XI**2+YJ**2)
      IF(DIST(I.1) .GE. DMIN) GO TO 120
      DMIN = DIST(I.1)
  120 IF(DIST(I+1) .LE. DMAX) GO TO 130
      DMAX = DIST(I \cdot 1)
  130 CCNTINUE
```

```
*** PROCESS HICEN **
    CO 150 I=1.KNEBR
        = MPCINT(I)
       = HICEN(J.1)-IROW
    YJ
    ΧI
       = HICEN(J.2)-JCOL
    KZI = HICEN(J.3)
    IF(KZI .GE. KZMIN) GO TO 35
    KZMIN = KZI
    GO TO 45
 35 IF (KZI .LE. KZMAX) GO TO 45
    KZMAX = KZI
 45 CONTINUE
    DIST(I_{\bullet}2) = SQRT(XI**2*YJ**2)
     IF(CIST(I+2) +GE+ DMIN) GO TO 140
    DMIN = DIST(I.2)
    GC TO 150
140 IF(DIST(I+2) .LE. DMAX) GO TO 150
    DMAX = DIST(I_{•}2)
150 CONTINUE
    IF(LWRIT .LE. 2) GO TO 75
    WRITE(6,900) NODE, COL, IROW, LNESR
    DO 50 LA=1.LNEBR.10
    LB = LA-1+19
    IF(LE .GT. LNEBR) LE=LNEER
 50 WRITE(6,901) (CIST(I,1), I=LA,LE)
    WRITE(6,900) NODE, JCOL, IROW, KNEBR
    DO 60 LA=1,KNEBR,10
    LE = LA-1+10
    IF(LE .GT. KNEBR) LE=KNEER
 60 WFITE(6.502) (DIST(1.2).I=LA.LS)
*** SCRT IN INCREASING ORDER **
 75 IF(LNEBR .EG. 1) GC TO 85
    KK = LNEBR-1
    00 250 J=1.KK
    JJ = J+1
    DO 250 I=JJ+LREER
    IF(DIST(J+1) .LE. DIST(I+1)) GC TC 250
    SA1 = DIST(J+1)
    JSA = IPCINT(J)
    DIST(J,1) = DIST(I,1)
    IPOINT(J) = IPOINT(I)
    DIST(I+1) = SA1
    IPOINT(I) = JSA
250 CONTINUE
 85 IF (KNEBR .EQ. 1) GC TO 300
    KK = KNEER-1
    CC 275 J=1.KK
    uJ = J+1
```

```
DO 275 I=JJ.KNEBR
      IF(DIST(J.2) .LE. DIST(I.2)) GO TO 275
      SA1 = DIST(J_{\bullet}2)
      JSA = MPOINT(J)
      DIST(0,2) = DIST(1,2)
      MPOINT(J) = MPOINT(I)
      DIST(I \cdot 2) = SA1
      MPOINT(I) = JSA
  275 CONTINUE
      IF (LWRIT .LE. 2) GC TO 300
      WRITE(6,903) DMIN,DMAX,KZMIN,KZMAX
      WRITE(6.500) NODE.JCOL.IROW.LNEBR
      DO 90 LA=1.LNEBR.10
      LB = LA-1+10
      IF (LB .GT. LNEER) LE=LNEBR
   90 WRITE(6.901) (DIST(I.1).I=LA.LB)
      WRITE(6,900) NCDE, JCGL, IROW, KNEER
      CC 95 LA=1.KNEBR.10
      LB = LA-1+10
      IF(LB .GT. KNEBR) LB=KNEBR
   95 WRITE(6,902) (CIST(I,2),I=LA,LB)
C *** CALCULATE PENALTY VALUE FOR POINTS
  3CO DRANG = DMAX-DMIN
      IF(DRANG .GT. 0.0) DRANG=1.0/DRANG
      ZRANG = KZMAX-KZMIN+1
      IF (ZRANG .GT. 0.0) ZRANG=1.0/ZRANG
      DO 320 I=1.LNEBR
      IFREE = IFREE+1
      IJ = IPOINT(I)
      LINKTO(IFREE+1) = IJ
      XYZ = LOWCEN(IJ.3)-KZMIN
      XYZ = DETLC(IJ)+XYZ+ZRANG
  32G LINKTO(IFREE+2) = 100+0+(XYZ+1-(DIST(I+1)-DMIN)+DRANG)
      CO 325 I=1.KNEBR
      IFREE = IFREE+1
      IJ = PPCINT(I)
      LINKTO(IFREE_{\bullet}1) = -IJ
      XYZ = HICEN(IJ.3)-KZMIN
      XYZ = DETHI(IJ)+XYZ*ZRANG
  325 \text{ LINKTO(IFREE,2)} = 100.0*(XYZ+1-(CIST(I,2)-DMIN)*CRANG)
      LINK(IC) = LSTR
      LSTR = IFREE+1
  9CO FCRMAT(/ 5X+*FROM DIFFER* / 5X+*NODE *+14+15+*+X-COCRD *+
     1 I5.*.Y-COORC *.I5.* LINKS*)
  901 FORMAT( 5x, *CISTANCE LOW *, 10(1x, F10, 3))
  902 FCRMAT( 5x+*CISTANCE HIGH *+10(1x+F10.3)/)
  903 FCRMAT(11X++CFIR++8X++DMAX KZFIR KZMAX+/
     1 5x,2(f10.4,2x),14,2x,14)
      RETURN
      END
```

```
SUBRCUTINE RITE
C *** THIS SUBROUTINE SAVES ARRAYS IN WORKING STORAGE
      COMMON/SENVEH/ LALT. HALT. SENALT. VEHALT. IFREE, GRID.
     1 SWEA.SWNR.LTPS
      CCMMON/KINK/ LINK(250).LINKTO(1500.3).NELKS.IC.
     1 IRADUS.LNEBR.KNEBR
      CCMMON/DET/ DETLO(250).DETHI(250).FRCM(250).TO(250.2)
      CCMMON/EDGE/ DIST(10G+2)+IRCW+JCCL+LSTR
      INTEGER FROM.TC
  *** BINARY UNFORMATTED TAPE
      WRITE(9) NBLKS.IFREE.IC
      WRITE(9) (FROM(I).I=1.IC)
      bRITE(9) ((TC(I+J)+J=1+2)+I=1+IC)
      WRITE(9) (LINK(1).I=1.IC)
      WRITE(9) ((LINKTC(I+J)+J=1+3)+I=1+IFREE)
      IFREE = IC = LSTR = 1
      NELKS = NBLKS+1
```

RETURN END

```
SUBROUTINE WRLINK
C
C
 *** THIS SUB! WRITES THE LINKAGE THAT!S EEEN CEVELOPED
      COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NHI.
         SMAX.LWRIT.LDEBG.JMAT.JSTRIP.LH
      COMMON/POINT/ INITIAL(3).LAST(3).IPOINT(250)
      COMMON/SERVEH/ LALT. HALT. SENALT. VEHALT. IFREE. GRID.
     1 SWEA.SWAR.LTRS
      COMMCN/KINK/ LINK(250).LINKTO(1500.3).NBLKS.IC.
     1 IRADUS.LNEBR.KNEBR
      COMMON/DET/ DETLC(250).DETHI(250).FROM(250).TO(250.2)
      INTEGER HICEN . FROM . TO
      WRITE(6,500)
  900 FCRMAT(1H1 /10X+*NODE LINKAGE CUTFUT*)
      WRITE (6.901) IFREE . NBLKS . NLOW . IRADUS
  901 FCRMAT(10X.*IFREE NELKS
                                     NLOW
                                            IRADUS*/
     1 10X,4(I6,1X))
      NM = IFREE+1
      CC 15 NA=1.NM.10
      NB = NA-1+10
   15 WRITE(6,902) (LINKTO(I,1), I=NA,NE), (LINKTC(I,2), I=NA,NE),
                   (LINKTO(I.3).I=NA.NB)
  902 FORMAT(16X+*LINKTO(I+1) *+10(2X+16)/
             10X++LINKTO(I+2)
                                *•10(2X•I6)/
             10X+*LINKTC(I+3)
                               *•10(2X+I6)/)
      WRITE(6.903)
  903 FORMAT(1+1)
      WRITE(6,504)
      CO 15 J=1.IC.10
      JJ = J-1+10
      IF(JJ .GT. IC) JU=IC
   10 WRITE(6.905) (LINK(I).I=J.JJ)
  904 FORMAT(/10x++LINKAGE POINTERS+/)
  905 FCRMAT(10X+10(16+2X))
      KC = C
      DC 20 NJ=1.IC
      IF(KC .EG. 0) WRITE(6.906)
      KC = KC+1
      NN = FROM(NJ)
         = LINK(NJ)
      JJ = LINK(NJ+1)-1
      IF(JJ .LT. 0) JJ=IFREE
      JJJ= JJ-J+1
      WRITE(6.507) AR.JJJ
      IF(NN .GT. 0) WRITE(6,908) LCWCEN(NA,2).
                     LOWCEN(NN.1).LOWCEN(NN.3)
      IF(NN .LT. 0) WRITE(6,908) HICEN(-NN.2).
                     HICEN(-NN+1)+HICEN(-NN+3)
     1
      WRITE(6,909) (LINKTO(I,1),I=J,JJ)
      WRITE(6,910) (LINKTO(I,2),I=J,JJ)
```

WRITE(6.911) (LINKTO(I.3).I=J.J)

```
IF(KC *LE* 5) GC TO 20
KC = 0
20 CONTINUE

C

906 FORMAT(1+1/////34X**NODE LINKAGE*)
907 FORMAT(/20X**NODE NO***15** TOTAL LINKS ***14)
908 FORMAT(20X**X**Y***Z COORDINATE ***14*1H** *1X**14)
909 FORMAT(20X**LINKED TO ***1017)
910 FORMAT(20X**EXPOSURE ***1017)
911 FORMAT(20X**EIGHTED ***1017)
RETURN
END
```

### SUBROUTINE SAVE \*\*\* THIS ROUTINE IS USED TO WRITE VALUES OUT FOR PLOTTING COMMON/LCENT/ LOWCEN(250.3).HICEN(250.3).KCET.NLOW.NHI. SMAX, LWRIT, LDEBG, JMAT, JSTRIP, LH COMMON/SENVEH/ LALT. HALT. SENALT. VEHALT. IFREE. GRID. 1 SWEA, SWNR, LTRS COMMON/KINK/ LINK(250).LINKTO(1500.3).NBLKS.IC. 1 IRADUS.LNEBR.KNEBR COMMON/DET/ CETLO(250), DETHI(250), FRCM(250), TO(250,2) INTEGER FICEN . FROM . TO C WRITE(7,900) NLOW, NHI, IC, IFREE WRITE(7,901) ((LOWCEN(I,J),J=1,3),I=1,NLOh) WRITE(7.501) ((HICEN(I.J).J=1.3).I=1.AFI) WRITE(7,902) (DETLC(I),I=1,NLOW) WRITE(7,902) (DETHI(I), I=1,NHI) WRITE(7.901) (FROM(I).I=1.IC) WRITE(7,901) ((TO(I,J),J=1,2),I=1,IC) brite(7.501) (LINK(I).I=1.IC) WRITE(7,901) ((LINKTC(I,J),J=1,3),I=1,IFPEE) 900 FORMAT(4110) 901 FORMAT(10(19,1X)) 902 FORMAT(10F10.3) RETURN

END

```
SUPRCUTINE RADIAL
C
  *** THIS ROUTINE CALCULATES THE LINE OF SIGHT (LGS)
      BETWEEN NODE POINT AND SENSORS. LOS IS THE
  *** INTERVISIBILITY BETWEEN PTS. ONCE ANY TERRAIN
  *** MASKING POINT IS FOUND PROCESSING OF THAT NODE-
 *** SENSOR COMBINATION IS FINISHED.
                                                           . . .
      COMMON/IDAT/ KMAT.ISTRIP.IDATA(15.15.10)
      COMMON/LCENT/ LOWCEN (250.3) . FICEN (250.3) . KCET. NLOW. NHI.
         SMAX, LWRIT, LDEEG, JMAT, JSTRIP, LF
      COMMON/PCINT/ INITIAL(3).LAST(3).IPCINT(250)
      COMMON/SERVEH/ LALT . HALT . SENALT . VEHALT . IFREE . GRIC .
     1 SWEA.SWNR.LTRS
      COMMCN/SRAD/ RANGE . RE. MDIM . RATE . NSITE . ISITE (10.3) . SYSR (10)
      COMMON/DET/ DETLO(250).DETHI(250).DISLO(250).
     1 DISHI(250).XX(250)
      DIMENSION IFINISH(250)
      INTEGER SENALT. VEHALT. HICEN, EAST. WEST. SOUTH. GRID
      LCGICAL ZCURVE + ZNORTH + ZSOUTH
      EGUIVALENCE (RMAX.DIS)
      DATA RE-SRTW--RATE/8490200-0-0-70716-8-1-0/
      DATA SENALT. VEHALT. MOIM/3.10.15/
C
C
         INITIALIZE
      REWIND &
      ZCURVE = RE.ST.0.0
      ZGRID = GRID
      RE
            = RE/ZGRID
      CZ
            = 0.0
 *** AREA LIMITS
      NORTH = KMAT+MCIM
      SOUTH = 1
C
      DC 2400 UK=1.ISTRIP
      JSTRIP = JK
      EAST = JSTRIF + MCIM
      WEST = (LSTRIP-1) *MDIM+1
      CALL INDATA
      LF = 1
      ILCOP = NLCW
      CO 2400 KLN=1.2
C
      DO 2000 KK=1.NSITE
      KSIT = ISITE(KK+2)
      YSIT = ISITE(KK.1)
      ZSIT = ISITE(KK+3)+SENALT
      CO 2000 LP=1.ILOOP
C *** TEST IFINISH FOR COMPLETION
```

The state of the s

IEXP = (LF-1)\*10\*KK-1

E THE SECTION

```
IFIN = AND(IFINISH(LP)+2**(IEXP))
      IF (IFIN .NE. 0) GO TO 2000
      IF(LH .EG. 2) GO TC 400
      KS1 = LOWCEN(LP.2)
      IF (((KS1.GT.EAST) .AND. (KSIT.GT.EAST))
     1 .OR.((KS1.LT.WEST) .AND. (KSIT.LT.WEST))) GO TO 2000
 *** DETERMINE WESTERN MOST POINT OF PAIR **
      IF ((KSIT-KS1) .GE. 0) GO TO 300
C
 *** SWAP SENSOR AND NODE **
      XP = KS1
      ΥP
         = LOWCEN(LP+1)
      ZP = LOWCEN(LP+3)+VEHALT
      KS1 = KSIT
      XS1 = KSIT
      YS1 = YSIT
      ZS1 = ZSIT
      GC TO 525
  300 XS1 = KS1
      YS1 = LOWCEN(LP+1)
      ZS1 = LOWCEN(LP+3)+VEHALT
      XP = KSIT
      YF = YSIT
      ZP = ZSIT
      GC TO 525
  400 KS1 = HICEN(LP,2)
     IF (((KS1.GT.EAST) .AND. (KSIT.GT.EAST))
     1 .OR. ((KS1.LT. WEST) .ANC. (KSIT.LT. WEST))) GO TO 2000
 *** DETERMINE WESTERN MOST POINT OF PAIR **
      IF((KSIT-KS1) .GE. 0) GO TC 418
 *** SWAP SENSOR AND NODE **
C
      XP = KS1
      YP = HICEN(LP.1)
      ZP = HICEN(LP.3)+VEHALT
      KS1 = KSIT
      XS1 = KSIT
      YS1 = YSIT
      ZS1 = ZSIT
     GO TO 525
  410 XS1 = KS1
      YS1 = HICEN(LP.1)
      ZS1 = HICEN(LP+3)+VEHALT
     XP = KSIT
```

```
YP
          = YSIT
      ZP
          = ZSIT
 *** CALCULATE TANGENT AND DISTANCE BETWEEN SENSOR/NODE
 *** THE AZIMUTH ANGLE IS MEASURED FROM NORTH CLOCKWISE
  525 \times SP = XP-XS1
      YSP = YP-YS1
      ZSP = ZP-ZS1
      DIS = SGRT(XSP**2 + YSP**2)
      IF(ZCURVE) DZ=0.5*DIS*(DIS/RE)
      TM = (ZSP-DZ)/(DIS*ZGRID)
      XSIN = XSP/DIS
      YCOS = YSP/DIS
      ZNORTH = .FALSE.
      ZSOUTH = .FALSE.
C
C *** DETERMINE STARTING INDICES AND MAP SHEET BOUNDARIES
   10 IF(KS1 .LT. WEST) GC TO 560
      NX = XS1-WEST
      YWEST = 0.0
      GC TO 570
  560 NX
         = 0
      YWEST = YCCS*((WEST~XS1)/XSIN)
  570 IF (ABS(XSIN).LE.SRTWH) GO TO 1150
Ç
C
         EAST
 * * *
C
      IX = NX
         = IX+WEST
      IDX = 1
 1020 IX = IX + ICX
          = X+RATE
      IF(IX .GT. MEIM) GC TO 2000
          = (x-xs1)/xsin
         = R*YCOS+YS1
      JY
      NAR = (JY-1)/MDIM
      JY = JY-NAR + MCIM
      NAR = NAR + 1
C *** TANGENT FOR ALL COMPASS DIRECTION
 *** IF NAR OUTSIDE MAP SHEET - LOS EXIST
 1075 IF((NAR .LT. SOUTH) .OR. (NAR .GT. \CRTH)) GO TO 18CC
      Z = ICATA(JY \bullet IX \bullet NAR)
      IF(ZCURVE) DZ=0.5*R*(R/RE)
      T = (Z-ZS1-DZ)/(R*ZGRID)
      IF(T .LE. TM) GO TO 1090
      GO TC 1900
 1090 IF(R .GE. RMAX) GC TO 1800
      IF (ZNCRTH) GC TC 1130
```

```
IF (ZSCUTH) GC TO 1135
      GC TO 1020
        NORTH
C ***
 1130 Y
        = Y+DY
      Y = JY+JDY
      IF(JY .LE. MCIM) GO TO 1140
      JY = 1
      NAR = NAR+1
      GO TC 1140
C ***
        SOUTH
C
 1135 Y = Y+DY
      JY = JY+JCY
      IF(JY .GE. 1) GO TC 1148
      JY = MCIM
      NAR = NAR-1
 1140 R = (Y-YS1)/YCOS
      IX = R * X S I N * X S I
      IF(IX .GT. MCIM) IX=IX-WEST+1
      IF(IX .GT. MEIM) GO TO 2000
      GC TO 1075
 1150 IF(YCOS .GT. 0.0) GO TO 1160
C
C ***
        SCLTH
                ***
      ZSOUTH = .TRLE.
      JY = YS1+YWEST-RATE
      NAR = (JY-1)/MCIM
      JY = JY-NAR * MCIM
      NAR = NAR+1
         = YS1+YWEST-RATE
      DY =-RATE
      JDY =-1
      GC TO 1140
C
С
        NORTH
 1160 ZNORTH = .TRLE.
      JY = YS1+YWEST
      NAR = JY/MDIM
      JY = JY+1-NAR+MOIM
      NAR = NAR+1
         = YS1+YWEST+RATE
      DY = RATE
      JEY = 1
      GO TO 1140
1800 IF(LH .EG. 2) GO TC 1850
      DETLO(LP) = CETLO(LP)+1.0
      DISLO(LP) = CISLO(LP)+DIS
```

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